

APPENDIX H

AIR QUALITY

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APPENDIX H.1

QUARTERLY WIND ROSES AND FREQUENCY DISTRIBUTION TABLES

BURBANK, 1981

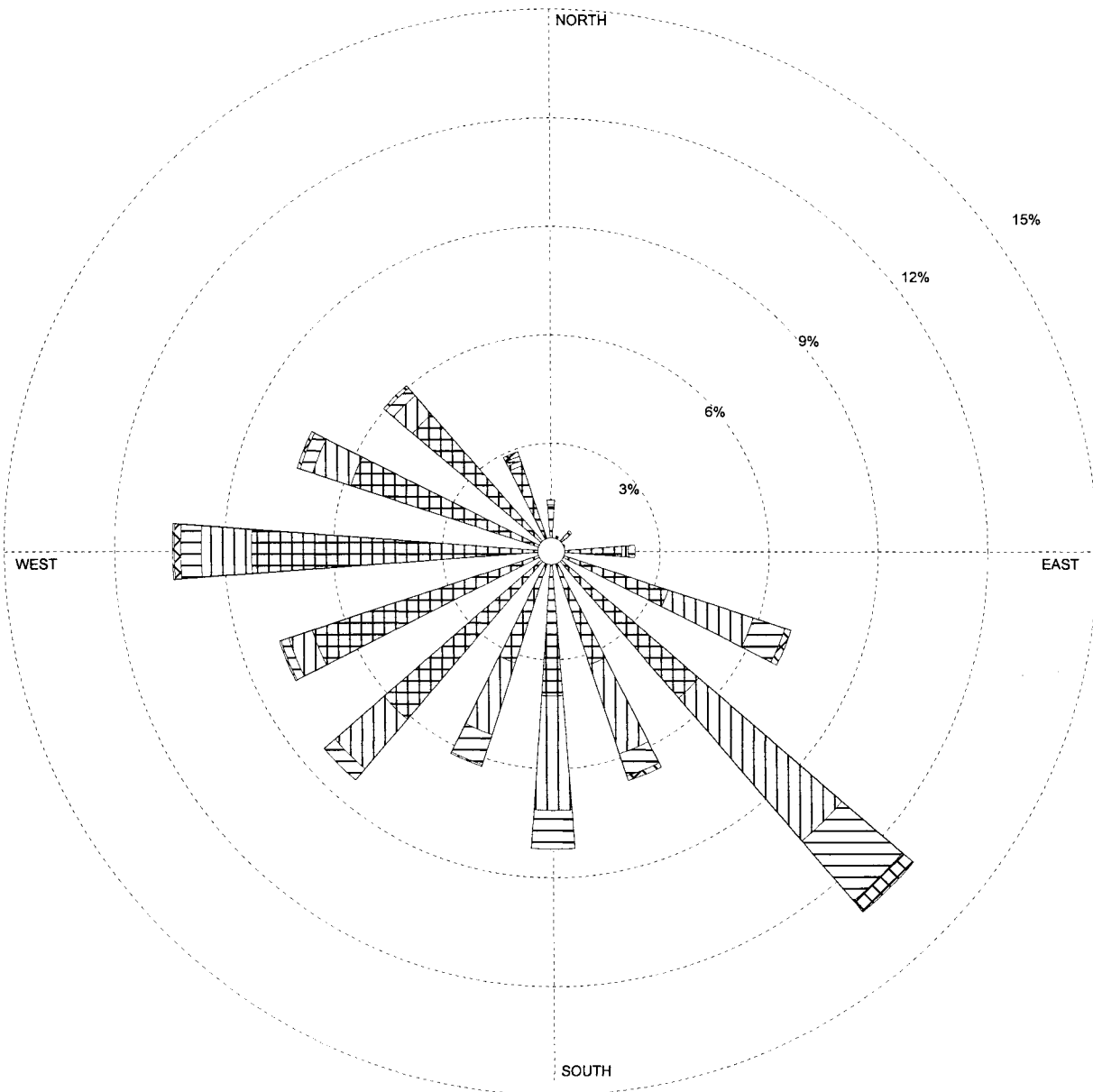
APPENDIX H.1.1

QUARTERLY WIND ROSES AND FREQUENCY DISTRIBUTION TABLES

BURBANK, 1981

WIND ROSE PLOT

STATION #51100 - Burbank, CA



 Wind Speed (m/s) > 10.8 8.8-10.8 5.7-8.8 3.6-5.7 2.1-3.6 0.5-2.1	MODELER L. Killion	DATE 3/6/01	COMPANY NAME
	DISPLAY Wind Speed	UNIT m/s	COMMENTS Burbank 1st Qtr 1981
	AVG. WIND SPEED 1.94 m/s	CALM WINDS 10.08%	
	ORIENTATION Direction (blowing from)	PLOT YEAR-DATE-TIME 81 January 1 - March 31 Midnight - 11 PM	PROJECT/PLOT NO. 1Q81

WRPLOT View 2.22 by Lakes Environmental Software - www.lakes-environmental.com

Station ID : 51100
 Years : 1981
 Start Date : January 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : March 31
 End Time : 11 PM

Frequency Distribution
 (Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	27	1	3	0	0	0	31
NNE	6	1	1	2	0	0	10
NE	9	1	1	4	2	0	17
ENE	5	0	4	0	0	0	9
E	42	4	4	0	0	0	50
ESE	73	53	20	4	0	0	150
SE	115	112	47	9	0	0	283
SSE	71	56	14	3	0	0	144
S	86	68	23	0	0	0	177
SSW	70	45	19	1	0	0	135
SW	132	39	9	0	0	0	180
WSW	150	15	5	1	0	0	171
W	178	30	12	4	1	0	225
WNW	125	24	8	2	0	0	159
NW	108	15	6	2	0	0	131
NNW	54	3	3	3	0	0	63
Total	1251	467	179	35	3	0	

Frequency of Calm Winds : 217

Average Wind Speed : 1.94 m/s

Station ID : 51100
 Years : 1981
 Start Date : January 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : March 31
 End Time : 11 PM

Frequency Distribution
 (Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

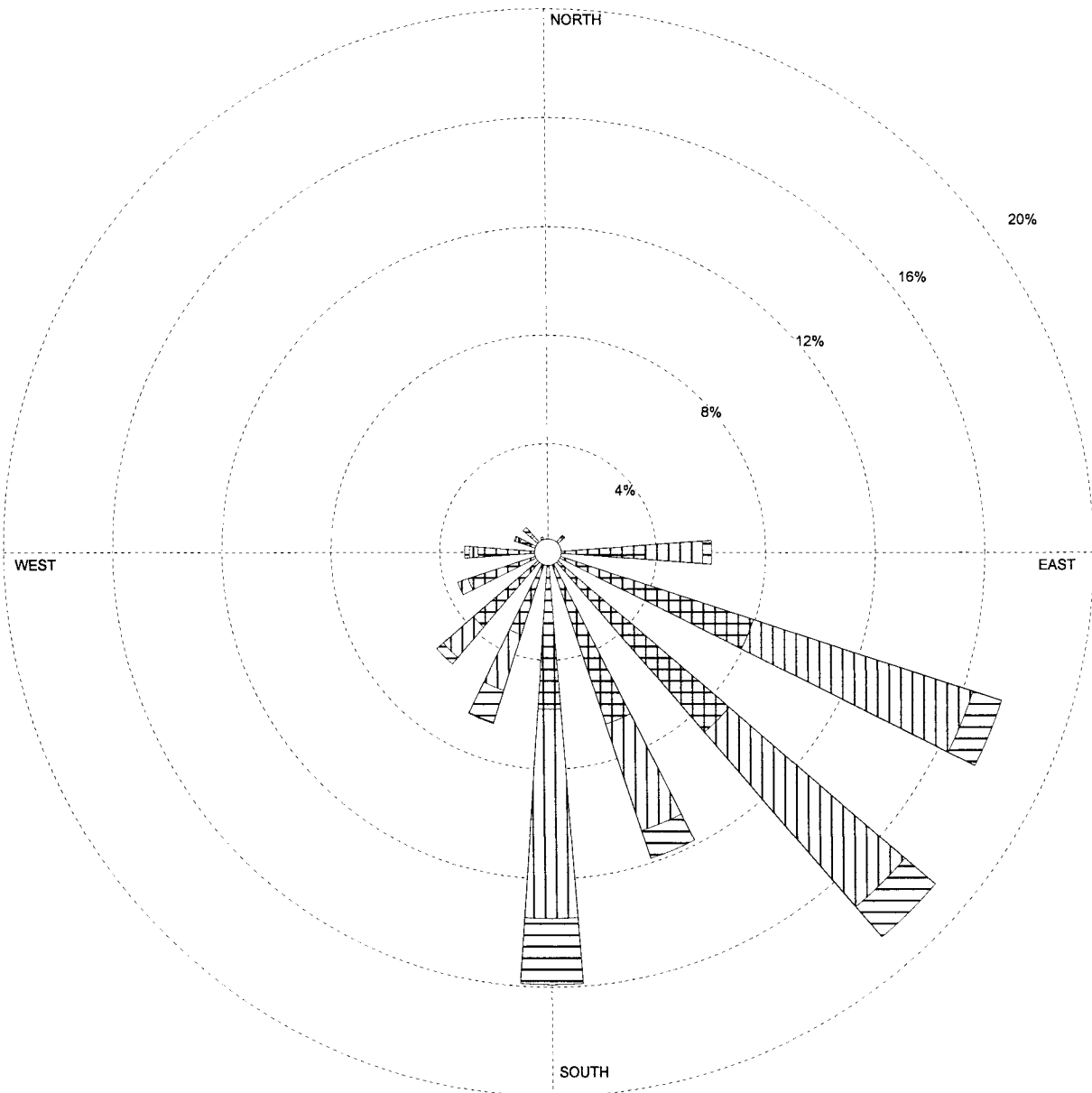
	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.012546	0.000465	0.001394	0.000000	0.000000	0.000000	0.014405
NNE	0.002788	0.000465	0.000465	0.000929	0.000000	0.000000	0.004647
NE	0.004182	0.000465	0.000465	0.001859	0.000929	0.000000	0.007900
ENE	0.002323	0.000000	0.001859	0.000000	0.000000	0.000000	0.004182
E	0.019517	0.001859	0.001859	0.000000	0.000000	0.000000	0.023234
ESE	0.033922	0.024628	0.009294	0.001859	0.000000	0.000000	0.069703
SE	0.053439	0.052045	0.021840	0.004182	0.000000	0.000000	0.131506
SSE	0.032993	0.026022	0.006506	0.001394	0.000000	0.000000	0.066914
S	0.039963	0.031599	0.010688	0.000000	0.000000	0.000000	0.082249
SSW	0.032528	0.020911	0.008829	0.000465	0.000000	0.000000	0.062732
SW	0.061338	0.018123	0.004182	0.000000	0.000000	0.000000	0.083643
WSW	0.069703	0.006970	0.002323	0.000465	0.000000	0.000000	0.079461
W	0.082714	0.013941	0.005576	0.001859	0.000465	0.000000	0.104554
WNW	0.058086	0.011152	0.003717	0.000929	0.000000	0.000000	0.073885
NW	0.050186	0.006970	0.002788	0.000929	0.000000	0.000000	0.060874
NNW	0.025093	0.001394	0.001394	0.001394	0.000000	0.000000	0.029275
Total	0.581320	0.217007	0.083178	0.016264	0.001394	0.000000	

Frequency of Calm Winds : 10.08%

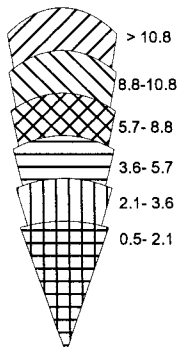
Average Wind Speed : 1.94 m/s

WIND ROSE PLOT

STATION #51100 - Burbank, CA



Wind Speed (m/s)



MODELER

L. Killion

DATE

3/6/01

COMPANY NAME

DISPLAY

Wind Speed

UNIT

m/s

COMMENTS

Burbank 2ndt Qtr 1981

AVG. WIND SPEED

2.12 m/s

CALM WINDS

6.28%

ORIENTATION

Direction
(blowing from)

PLOT YEAR-DATE-TIME

81
April 1 - June 30
Midnight - 11 PM

PROJECT/PLOT NO.

2Q81

Station ID : 51100
 Years : 1981
 Start Date : April 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : June 30
 End Time : 11 PM

Frequency Distribution
 (Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	2	1	0	0	0	0	3
NNE	2	1	2	0	0	0	5
NE	2	1	13	1	1	1	19
ENE	6	1	1	0	0	0	8
E	79	45	7	0	0	0	131
ESE	172	183	24	0	0	0	379
SE	190	183	32	0	0	0	405
SSE	145	89	23	0	0	0	257
S	126	166	53	0	0	0	345
SSW	70	47	27	1	0	0	145
SW	80	32	7	0	0	0	119
WSW	68	9	0	0	0	0	77
W	56	7	4	0	0	0	67
WNW	24	4	1	0	0	0	29
NW	17	2	8	0	0	0	27
NNW	9	3	2	0	0	0	14
Total	1048	774	204	2	1	1	

Frequency of Calm Winds : 136
 Average Wind Speed : 2.12 m/s

Station ID : 51100
 Years : 1981
 Start Date : April 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : June 30
 End Time : 11 PM

Frequency Distribution
 (Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

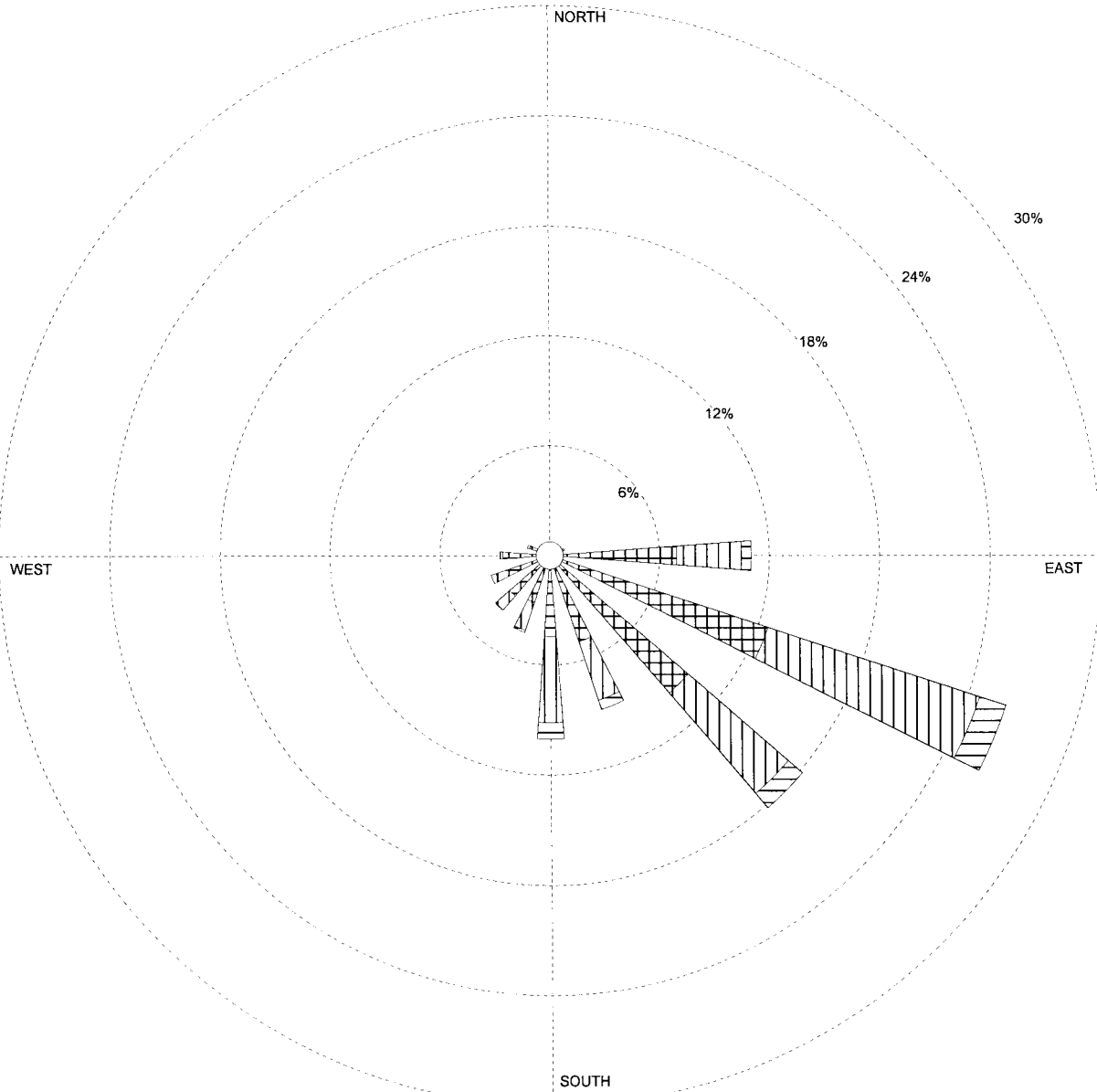
	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.000923	0.000462	0.000000	0.000000	0.000000	0.000000	0.001385
NNE	0.000923	0.000462	0.000923	0.000000	0.000000	0.000000	0.002308
NE	0.000923	0.000462	0.006002	0.000462	0.000462	0.000462	0.008772
ENE	0.002770	0.000462	0.000462	0.000000	0.000000	0.000000	0.003693
E	0.036473	0.020776	0.003232	0.000000	0.000000	0.000000	0.060480
ESE	0.079409	0.084488	0.011080	0.000000	0.000000	0.000000	0.174977
SE	0.087719	0.084488	0.014774	0.000000	0.000000	0.000000	0.186981
SSE	0.066944	0.041090	0.010619	0.000000	0.000000	0.000000	0.118652
S	0.058172	0.076639	0.024469	0.000000	0.000000	0.000000	0.159280
SSW	0.032318	0.021699	0.012465	0.000462	0.000000	0.000000	0.066944
SW	0.036934	0.014774	0.003232	0.000000	0.000000	0.000000	0.054940
WSW	0.031394	0.004155	0.000000	0.000000	0.000000	0.000000	0.035549
W	0.025854	0.003232	0.001847	0.000000	0.000000	0.000000	0.030933
WNW	0.011080	0.001847	0.000462	0.000000	0.000000	0.000000	0.013389
NW	0.007849	0.000923	0.003693	0.000000	0.000000	0.000000	0.012465
NNW	0.004155	0.001385	0.000923	0.000000	0.000000	0.000000	0.006464
Total	0.483841	0.357341	0.094183	0.000923	0.000462	0.000462	

Frequency of Calm Winds : 6.28%

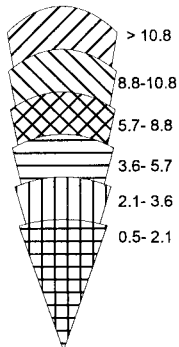
Average Wind Speed : 2.12 m/s

WIND ROSE PLOT

STATION #51100 - Burbank, CA



Wind Speed (m/s)



MODELER

L. Killion

DATE

3/6/01

COMPANY NAME

DISPLAY

Wind Speed

UNIT

m/s

COMMENTS

Burbank 3rd Qtr 1981

AVG. WIND SPEED

1.94 m/s

CALM WINDS

7.87%

ORIENTATION

Direction
(blowing from)

PLOT YEAR-DATE-TIME

81
July 1 - September 30
Midnight - 11 PM

PROJECT/PLOT NO.

3Q81

Station ID : 51100
 Years : 1981
 Start Date : July 1
 Start Time : Midnight

RUN ID :
 End Date : September 30
 End Time : 11 PM

Frequency Distribution
 (Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	4	0	0	0	0	0	4
NNE	1	0	0	0	0	0	1
NE	2	0	0	0	0	0	2
ENE	15	2	2	0	0	0	19
E	153	78	12	0	0	0	243
ESE	276	266	33	0	0	0	575
SE	219	159	23	0	0	0	401
SSE	110	74	12	0	0	0	196
S	98	104	20	0	0	0	222
SSW	60	36	3	0	0	0	99
SW	64	23	1	0	0	0	88
WSW	69	6	0	0	0	0	75
W	57	3	0	0	1	0	61
WNW	26	3	0	0	0	0	29
NW	6	2	0	0	0	0	8
NNW	3	0	0	0	0	0	3
Total	1163	756	106	0	1	0	

Frequency of Calm Winds : 173

Average Wind Speed : 1.94 m/s

Station ID : 51100
 Years : 1981
 Start Date : July 1
 Start Time : Midnight

RUN ID :
 End Date : September 30
 End Time : 11 PM

Frequency Distribution
 (Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

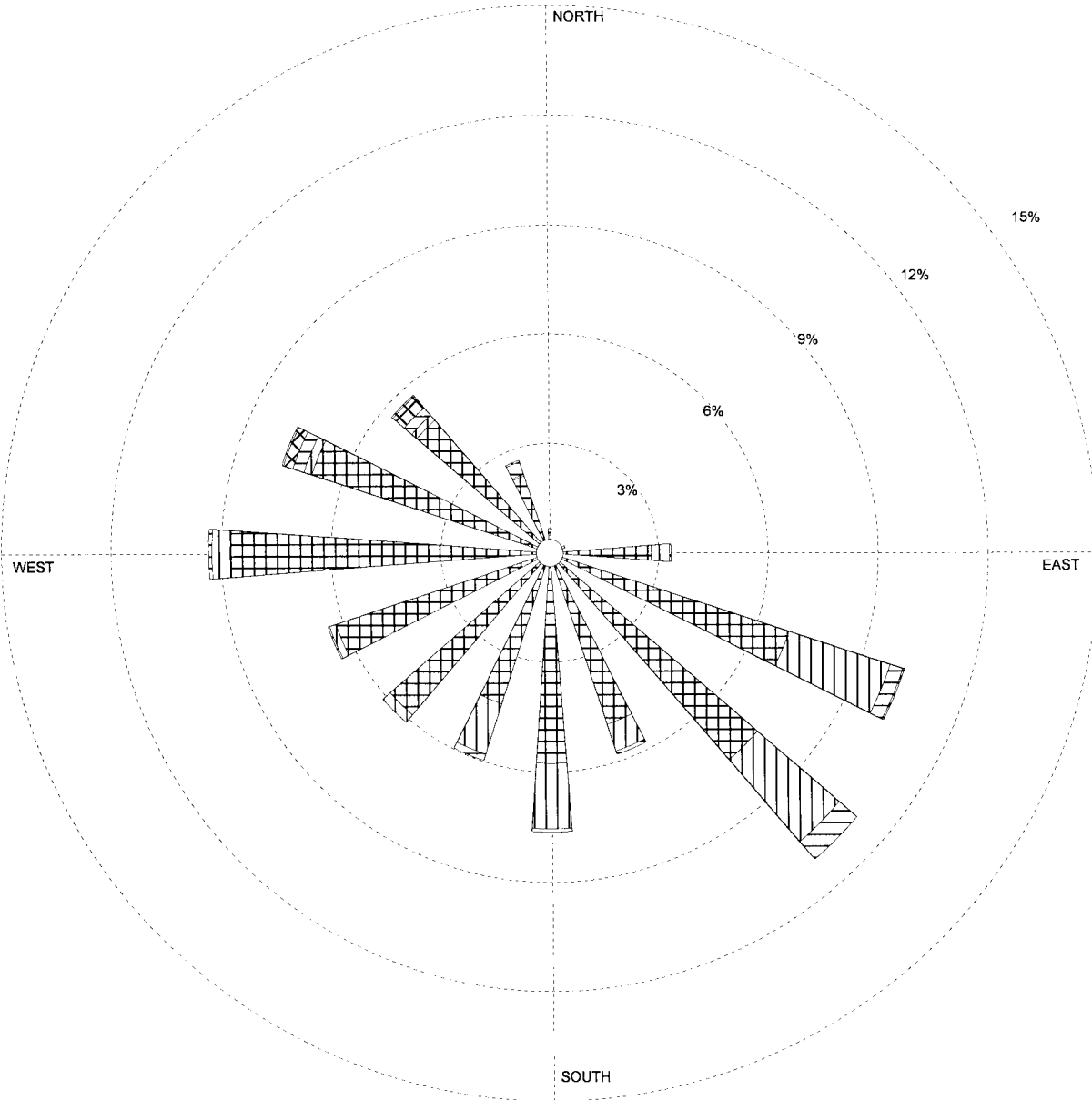
	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.001819	0.000000	0.000000	0.000000	0.000000	0.000000	0.001819
NNE	0.000455	0.000000	0.000000	0.000000	0.000000	0.000000	0.000455
NE	0.000910	0.000000	0.000000	0.000000	0.000000	0.000000	0.000910
ENE	0.006821	0.000910	0.000910	0.000000	0.000000	0.000000	0.008640
E	0.069577	0.035471	0.005457	0.000000	0.000000	0.000000	0.110505
ESE	0.125512	0.120964	0.015007	0.000000	0.000000	0.000000	0.261482
SE	0.099591	0.072306	0.010459	0.000000	0.000000	0.000000	0.182356
SSE	0.050023	0.033652	0.005457	0.000000	0.000000	0.000000	0.089131
S	0.044566	0.047294	0.009095	0.000000	0.000000	0.000000	0.100955
SSW	0.027285	0.016371	0.001364	0.000000	0.000000	0.000000	0.045020
SW	0.029104	0.010459	0.000455	0.000000	0.000000	0.000000	0.040018
WSW	0.031378	0.002729	0.000000	0.000000	0.000000	0.000000	0.034106
W	0.025921	0.001364	0.000000	0.000000	0.000455	0.000000	0.027740
WNW	0.011824	0.001364	0.000000	0.000000	0.000000	0.000000	0.013188
NW	0.002729	0.000910	0.000000	0.000000	0.000000	0.000000	0.003638
NNW	0.001364	0.000000	0.000000	0.000000	0.000000	0.000000	0.001364
Total	0.528877	0.343793	0.048204	0.000000	0.000455	0.000000	

Frequency of Calm Winds : 7.87%

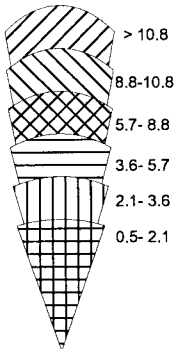
Average Wind Speed : 1.94 m/s

WIND ROSE PLOT

STATION #51100 - Burbank, CA



Wind Speed (m/s)



MODELER

L. Killion

DATE

3/6/01

COMPANY NAME

DISPLAY

Wind Speed

UNIT

m/s

COMMENTS

Burbank 4th Qtr 1981

AVG. WIND SPEED

1.51 m/s

CALM WINDS

16.26%

ORIENTATION

Direction
(blowing from)

PLOT YEAR-DATE-TIME

81
October 1 - December 31
Midnight - 11 PM

PROJECT/PLOT NO.

4Q81

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : October 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	11	1	3	0	0	0	15
NNE	4	2	1	0	0	0	7
NE	3	0	0	0	0	0	3
ENE	10	0	0	0	0	0	10
E	62	11	1	0	0	0	74
ESE	152	64	8	1	0	0	225
SE	165	65	14	0	0	0	244
SSE	109	17	2	0	0	0	128
S	127	39	2	0	0	0	168
SSW	96	32	4	0	0	0	132
SW	129	6	0	0	0	0	135
WSW	137	4	1	0	0	0	142
W	193	11	2	0	0	0	206
WNW	151	5	7	6	1	0	170
NW	106	4	6	9	1	0	126
NNW	49	1	8	0	1	0	59
Total	1504	262	59	16	3	0	

Frequency of Calm Winds : 358

Average Wind Speed : 1.51 m/s

Station ID : 51100
 Years : 1981
 Start Date : October 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : December 31
 End Time : 11 PM

Frequency Distribution
 (Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.004995	0.000454	0.001362	0.000000	0.000000	0.000000	0.006812
NNE	0.001817	0.000908	0.000454	0.000000	0.000000	0.000000	0.003179
NE	0.001362	0.000000	0.000000	0.000000	0.000000	0.000000	0.001362
ENE	0.004541	0.000000	0.000000	0.000000	0.000000	0.000000	0.004541
E	0.028156	0.004995	0.000454	0.000000	0.000000	0.000000	0.033606
ESE	0.069028	0.029064	0.003633	0.000454	0.000000	0.000000	0.102180
SE	0.074932	0.029519	0.006358	0.000000	0.000000	0.000000	0.110808
SSE	0.049500	0.007720	0.000908	0.000000	0.000000	0.000000	0.058129
S	0.057675	0.017711	0.000908	0.000000	0.000000	0.000000	0.076294
SSW	0.043597	0.014532	0.001817	0.000000	0.000000	0.000000	0.059946
SW	0.058583	0.002725	0.000000	0.000000	0.000000	0.000000	0.061308
WSW	0.062216	0.001817	0.000454	0.000000	0.000000	0.000000	0.064487
W	0.087648	0.004995	0.000908	0.000000	0.000000	0.000000	0.093551
WNW	0.068574	0.002271	0.003179	0.002725	0.000454	0.000000	0.077203
NW	0.048138	0.001817	0.002725	0.004087	0.000454	0.000000	0.057221
NNW	0.022252	0.000454	0.003633	0.000000	0.000454	0.000000	0.026794
Total	0.683015	0.118983	0.026794	0.007266	0.001362	0.000000	

Frequency of Calm Winds : 16.26%

Average Wind Speed : 1.51 m/s

APPENDIX H.1.2
ANNUAL FREQUENCY DISTRIBUTION TABLES BY STABILITY CLASS
BURBANK, 1981

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	5	6	0	0	0	0	11
ESE	18	35	0	0	0	0	53
SE	29	30	0	0	0	0	59
SSE	19	10	0	0	0	0	29
S	15	18	0	0	0	0	33
SSW	6	6	0	0	0	0	12
SW	6	2	0	0	0	0	8
WSW	8	1	0	0	0	0	9
W	3	1	0	0	0	0	4
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Total	111	110	0	0	0	0	

Frequency of Calm Winds : 4

Average Wind Speed : 1.91 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.004444	0.000000	0.000000	0.000000	0.000000	0.000000	0.004444
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.004444	0.000000	0.000000	0.000000	0.000000	0.000000	0.004444
ENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.022222	0.026667	0.000000	0.000000	0.000000	0.000000	0.048889
ESE	0.080000	0.155556	0.000000	0.000000	0.000000	0.000000	0.235556
SE	0.128889	0.133333	0.000000	0.000000	0.000000	0.000000	0.262222
SSE	0.084444	0.044444	0.000000	0.000000	0.000000	0.000000	0.128889
S	0.066667	0.080000	0.000000	0.000000	0.000000	0.000000	0.146667
SSW	0.026667	0.026667	0.000000	0.000000	0.000000	0.000000	0.053333
SW	0.026667	0.008889	0.000000	0.000000	0.000000	0.000000	0.035556
WSW	0.035556	0.004444	0.000000	0.000000	0.000000	0.000000	0.040000
W	0.013333	0.004444	0.000000	0.000000	0.000000	0.000000	0.017778
WNW	0.000000	0.004444	0.000000	0.000000	0.000000	0.000000	0.004444
NW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Total	0.493333	0.488889	0.000000	0.000000	0.000000	0.000000	

Frequency of Calm Winds : 1.78%

Average Wind Speed : 1.91 m/s

**STABILITY CLASS A
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	1	0	0	0	0	0	1
NNE	0	0	0	0	0	0	0
NE	1	0	0	0	0	0	1
ENE	0	0	0	0	0	0	0
E	5	6	0	0	0	0	11
ESE	18	35	0	0	0	0	53
SE	29	30	0	0	0	0	59
SSE	19	10	0	0	0	0	29
S	15	18	0	0	0	0	33
SSW	6	6	0	0	0	0	12
SW	6	2	0	0	0	0	8
WSW	8	1	0	0	0	0	9
W	3	1	0	0	0	0	4
WNW	0	1	0	0	0	0	1
NW	0	0	0	0	0	0	0
NNW	0	0	0	0	0	0	0
Total	111	110	0	0	0	0	

Frequency of Calm Winds : 4

Average Wind Speed : 1.91 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.004444	0.000000	0.000000	0.000000	0.000000	0.000000	0.004444
NNE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NE	0.004444	0.000000	0.000000	0.000000	0.000000	0.000000	0.004444
ENE	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
E	0.022222	0.026667	0.000000	0.000000	0.000000	0.000000	0.048889
ESE	0.080000	0.155556	0.000000	0.000000	0.000000	0.000000	0.235556
SE	0.128889	0.133333	0.000000	0.000000	0.000000	0.000000	0.262222
SSE	0.084444	0.044444	0.000000	0.000000	0.000000	0.000000	0.128889
S	0.066667	0.080000	0.000000	0.000000	0.000000	0.000000	0.146667
SSW	0.026667	0.026667	0.000000	0.000000	0.000000	0.000000	0.053333
SW	0.026667	0.008889	0.000000	0.000000	0.000000	0.000000	0.035556
WSW	0.035556	0.004444	0.000000	0.000000	0.000000	0.000000	0.040000
W	0.013333	0.004444	0.000000	0.000000	0.000000	0.000000	0.017778
WNW	0.000000	0.004444	0.000000	0.000000	0.000000	0.000000	0.004444
NW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
NNW	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
Total	0.493333	0.488889	0.000000	0.000000	0.000000	0.000000	

Frequency of Calm Winds : 1.78%

Average Wind Speed : 1.91 m/s

**STABILITY CLASS B
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	43	3	6	0	0	0	52
NNE	13	4	4	2	0	0	23
NE	15	2	14	5	3	1	40
ENE	36	3	7	0	0	0	46
E	331	132	24	0	0	0	487
ESE	655	531	85	5	0	0	1276
SE	660	489	116	9	0	0	1274
SSE	416	226	51	3	0	0	696
S	440	373	104	0	0	0	917
SSW	290	154	53	2	0	0	499
SW	399	98	17	0	0	0	514
WSW	416	33	6	1	0	0	456
W	481	50	18	4	2	0	555
WNW	326	35	16	8	1	0	386
NW	237	23	20	11	1	0	292
NNW	115	7	13	3	1	0	139
Total	4873	2163	554	53	8	1	

Frequency of Calm Winds : 883

Average Wind Speed : 1.89 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.005038	0.000351	0.000703	0.000000	0.000000	0.000000	0.006093
NNE	0.001523	0.000469	0.000469	0.000234	0.000000	0.000000	0.002695
NE	0.001757	0.000234	0.001640	0.000586	0.000351	0.000117	0.004687
ENE	0.004218	0.000351	0.000820	0.000000	0.000000	0.000000	0.005390
E	0.038781	0.015466	0.002812	0.000000	0.000000	0.000000	0.057059
ESE	0.076743	0.062214	0.009959	0.000586	0.000000	0.000000	0.149502
SE	0.077329	0.057293	0.013591	0.001054	0.000000	0.000000	0.149268
SSE	0.048740	0.026479	0.005975	0.000351	0.000000	0.000000	0.081547
S	0.051552	0.043702	0.012185	0.000000	0.000000	0.000000	0.107440
SSW	0.033978	0.018043	0.006210	0.000234	0.000000	0.000000	0.058465
SW	0.046749	0.011482	0.001992	0.000000	0.000000	0.000000	0.060223
WSW	0.048740	0.003866	0.000703	0.000117	0.000000	0.000000	0.053427
W	0.056356	0.005858	0.002109	0.000469	0.000234	0.000000	0.065026
WNW	0.038196	0.004101	0.001875	0.000937	0.000117	0.000000	0.045226
NW	0.027768	0.002695	0.002343	0.001289	0.000117	0.000000	0.034212
NNW	0.013474	0.000820	0.001523	0.000351	0.000117	0.000000	0.016286
Total	0.570943	0.253427	0.064909	0.006210	0.000937	0.000117	

Frequency of Calm Winds : 10.35%

Average Wind Speed : 1.89 m/s

**STABILITY CLASS C
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	41	2	6	0	0	0	49
NNE	13	3	4	2	0	0	22
NE	13	2	14	5	3	1	38
ENE	34	2	6	0	0	0	42
E	322	102	24	0	0	0	448
ESE	613	412	77	5	0	0	1107
SE	576	358	107	9	0	0	1050
SSE	354	136	45	3	0	0	538
S	365	214	91	0	0	0	670
SSW	246	107	50	2	0	0	405
SW	354	74	16	0	0	0	444
WSW	380	24	6	1	0	0	411
W	450	42	18	4	2	0	516
WNW	313	30	16	8	1	0	368
NW	229	23	20	11	1	0	284
NNW	114	7	13	3	1	0	138
Total	4417	1538	513	53	8	1	

Frequency of Calm Winds : 855

Average Wind Speed : 1.84 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.005552	0.000271	0.000812	0.000000	0.000000	0.000000	0.006635
NNE	0.001760	0.000406	0.000542	0.000271	0.000000	0.000000	0.002979
NE	0.001760	0.000271	0.001896	0.000677	0.000406	0.000135	0.005146
ENE	0.004604	0.000271	0.000812	0.000000	0.000000	0.000000	0.005687
E	0.043602	0.013812	0.003250	0.000000	0.000000	0.000000	0.060664
ESE	0.083006	0.055789	0.010427	0.000677	0.000000	0.000000	0.149898
SE	0.077996	0.048477	0.014489	0.001219	0.000000	0.000000	0.142180
SSE	0.047935	0.018416	0.006093	0.000406	0.000000	0.000000	0.072850
S	0.049425	0.028978	0.012322	0.000000	0.000000	0.000000	0.090724
SSW	0.033311	0.014489	0.006770	0.000271	0.000000	0.000000	0.054841
SW	0.047935	0.010020	0.002167	0.000000	0.000000	0.000000	0.060122
WSW	0.051456	0.003250	0.000812	0.000135	0.000000	0.000000	0.055653
W	0.060934	0.005687	0.002437	0.000542	0.000271	0.000000	0.069871
WNW	0.042383	0.004062	0.002167	0.001083	0.000135	0.000000	0.049831
NW	0.031009	0.003114	0.002708	0.001490	0.000135	0.000000	0.038456
NNW	0.015437	0.000948	0.001760	0.000406	0.000135	0.000000	0.018687
Total	0.598104	0.208260	0.069465	0.007177	0.001083	0.000135	

Frequency of Calm Winds : 11.58%

Average Wind Speed : 1.84 m/s

**STABILITY CLASS D
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	37	2	6	0	0	0	45
NNE	10	1	1	2	0	0	14
NE	13	0	13	4	3	1	34
ENE	34	1	5	0	0	0	40
E	316	74	12	0	0	0	402
ESE	577	355	61	5	0	0	998
SE	514	291	82	9	0	0	896
SSE	301	92	25	3	0	0	421
S	286	107	32	0	0	0	425
SSW	196	51	23	2	0	0	272
SW	300	42	11	0	0	0	353
WSW	343	19	5	1	0	0	368
W	415	38	14	4	2	0	473
WNW	295	27	15	8	1	0	346
NW	218	18	19	11	1	0	267
NNW	113	7	11	3	1	0	135
Total	3968	1125	335	52	8	1	

Frequency of Calm Winds : 792

Average Wind Speed : 1.75 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.005891	0.000318	0.000955	0.000000	0.000000	0.000000	0.007164
NNE	0.001592	0.000159	0.000159	0.000318	0.000000	0.000000	0.002229
NE	0.002070	0.000000	0.002070	0.000637	0.000478	0.000159	0.005413
ENE	0.005413	0.000159	0.000796	0.000000	0.000000	0.000000	0.006368
E	0.050310	0.011782	0.001911	0.000000	0.000000	0.000000	0.064003
ESE	0.091864	0.056520	0.009712	0.000796	0.000000	0.000000	0.158892
SE	0.081834	0.046330	0.013055	0.001433	0.000000	0.000000	0.142652
SSE	0.047922	0.014647	0.003980	0.000478	0.000000	0.000000	0.067028
S	0.045534	0.017036	0.005095	0.000000	0.000000	0.000000	0.067664
SSW	0.031205	0.008120	0.003662	0.000318	0.000000	0.000000	0.043305
SW	0.047763	0.006687	0.001751	0.000000	0.000000	0.000000	0.056201
WSW	0.054609	0.003025	0.000796	0.000159	0.000000	0.000000	0.058589
W	0.066072	0.006050	0.002229	0.000637	0.000318	0.000000	0.075306
WNW	0.046967	0.004299	0.002388	0.001274	0.000159	0.000000	0.055087
NW	0.034708	0.002866	0.003025	0.001751	0.000159	0.000000	0.042509
NNW	0.017991	0.001114	0.001751	0.000478	0.000159	0.000000	0.021493
Total	0.631747	0.179112	0.053335	0.008279	0.001274	0.000159	

Frequency of Calm Winds : 12.61%

Average Wind Speed : 1.75 m/s

**STABILITY CLASS E
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	29	2	2	0	0	0	33
NNE	6	0	1	1	0	0	8
NE	11	0	3	1	0	0	15
ENE	31	1	2	0	0	0	34
E	273	56	1	0	0	0	330
ESE	495	223	12	0	0	0	730
SE	369	144	9	0	0	0	522
SSE	139	21	1	0	0	0	161
S	135	14	0	0	0	0	149
SSW	106	5	1	0	0	0	112
SW	182	13	0	0	0	0	195
WSW	268	11	3	0	0	0	282
W	331	22	6	0	0	0	359
WNW	259	17	9	0	0	0	285
NW	195	12	9	0	0	0	216
NNW	101	2	4	1	0	0	108
Total	2930	543	63	3	0	0	

Frequency of Calm Winds : 644

Average Wind Speed : 1.46 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.006933	0.000478	0.000478	0.000000	0.000000	0.000000	0.007889
NNE	0.001434	0.000000	0.000239	0.000239	0.000000	0.000000	0.001913
NE	0.002630	0.000000	0.000717	0.000239	0.000000	0.000000	0.003586
ENE	0.007411	0.000239	0.000478	0.000000	0.000000	0.000000	0.008128
E	0.065264	0.013388	0.000239	0.000000	0.000000	0.000000	0.078891
ESE	0.118336	0.053311	0.002869	0.000000	0.000000	0.000000	0.174516
SE	0.088214	0.034425	0.002152	0.000000	0.000000	0.000000	0.124791
SSE	0.033230	0.005020	0.000239	0.000000	0.000000	0.000000	0.038489
S	0.032273	0.003347	0.000000	0.000000	0.000000	0.000000	0.035620
SSW	0.025341	0.001195	0.000239	0.000000	0.000000	0.000000	0.026775
SW	0.043509	0.003108	0.000000	0.000000	0.000000	0.000000	0.046617
WSW	0.064069	0.002630	0.000717	0.000000	0.000000	0.000000	0.067416
W	0.079130	0.005259	0.001434	0.000000	0.000000	0.000000	0.085824
WNW	0.061917	0.004064	0.002152	0.000000	0.000000	0.000000	0.068133
NW	0.046617	0.002869	0.002152	0.000000	0.000000	0.000000	0.051638
NNW	0.024145	0.000478	0.000956	0.000239	0.000000	0.000000	0.025819
Total	0.700454	0.129811	0.015061	0.000717	0.000000	0.000000	

Frequency of Calm Winds : 15.40%

Average Wind Speed : 1.46 m/s

**STABILITY CLASS F
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100
 Years : 1981 1981
 Start Date : January 1
 Start Time : Midnight

RUN ID : Burbank
 End Date : December 31
 End Time : 11 PM

Frequency Distribution
 (Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	22	1	0	0	0	0	23
NNE	5	0	0	0	0	0	5
NE	10	0	0	0	0	0	10
ENE	30	0	1	0	0	0	31
E	247	38	0	0	0	0	285
ESE	413	128	1	0	0	0	542
SE	300	79	0	0	0	0	379
SSE	95	6	0	0	0	0	101
S	84	1	0	0	0	0	85
SSW	85	1	0	0	0	0	86
SW	145	6	0	0	0	0	151
WSW	206	7	0	0	0	0	213
W	280	15	0	0	0	0	295
WNW	226	11	1	0	0	0	238
NW	178	5	0	0	0	0	183
NNW	95	1	0	0	0	0	96
Total	2421	299	3	0	0	0	

Frequency of Calm Winds : 568

Average Wind Speed : 1.33 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.006685	0.000304	0.000000	0.000000	0.000000	0.000000	0.006989
NNE	0.001519	0.000000	0.000000	0.000000	0.000000	0.000000	0.001519
NE	0.003039	0.000000	0.000000	0.000000	0.000000	0.000000	0.003039
ENE	0.009116	0.000000	0.000304	0.000000	0.000000	0.000000	0.009420
E	0.075053	0.011547	0.000000	0.000000	0.000000	0.000000	0.086600
ESE	0.125494	0.038894	0.000304	0.000000	0.000000	0.000000	0.164692
SE	0.091158	0.024005	0.000000	0.000000	0.000000	0.000000	0.115163
SSE	0.028867	0.001823	0.000000	0.000000	0.000000	0.000000	0.030690
S	0.025524	0.000304	0.000000	0.000000	0.000000	0.000000	0.025828
SSW	0.025828	0.000304	0.000000	0.000000	0.000000	0.000000	0.026132
SW	0.044060	0.001823	0.000000	0.000000	0.000000	0.000000	0.045883
WSW	0.062595	0.002127	0.000000	0.000000	0.000000	0.000000	0.064722
W	0.085081	0.004558	0.000000	0.000000	0.000000	0.000000	0.089638
WNW	0.068672	0.003342	0.000304	0.000000	0.000000	0.000000	0.072318
NW	0.054087	0.001519	0.000000	0.000000	0.000000	0.000000	0.055606
NNW	0.028867	0.000304	0.000000	0.000000	0.000000	0.000000	0.029170
Total	0.735643	0.090854	0.000912	0.000000	0.000000	0.000000	

Frequency of Calm Winds : 17.26%

Average Wind Speed : 1.33 m/s

**STABILITY CLASS G
FREQUENCY DISTRIBUTION
BURBANK, 1981**

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Count)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	16	0	0	0	0	0	16
NNE	4	0	0	0	0	0	4
NE	7	0	0	0	0	0	7
ENE	18	0	0	0	0	0	18
E	132	0	0	0	0	0	132
ESE	222	0	0	0	0	0	222
SE	160	0	0	0	0	0	160
SSE	43	0	0	0	0	0	43
S	50	0	0	0	0	0	50
SSW	60	0	0	0	0	0	60
SW	95	0	0	0	0	0	95
WSW	142	0	0	0	0	0	142
W	207	0	0	0	0	0	207
WNW	163	0	0	0	0	0	163
NW	141	0	0	0	0	0	141
NNW	72	0	0	0	0	0	72
Total	1532	0	0	0	0	0	

Frequency of Calm Winds : 438

Average Wind Speed : 1.09 m/s

Station ID : 51100

RUN ID : Burbank

Years : 1981

Start Date : January 1

End Date : December 31

Start Time : Midnight

End Time : 11 PM

Frequency Distribution
(Normalized)

Wind Direction (Blowing From) / Wind Speed (m/s)

	0.51-2.06	2.06-3.60	3.60-5.66	5.66-8.75	8.75-10.80	>10.80	Total
N	0.008122	0.000000	0.000000	0.000000	0.000000	0.000000	0.008122
NNE	0.002030	0.000000	0.000000	0.000000	0.000000	0.000000	0.002030
NE	0.003553	0.000000	0.000000	0.000000	0.000000	0.000000	0.003553
ENE	0.009137	0.000000	0.000000	0.000000	0.000000	0.000000	0.009137
E	0.067005	0.000000	0.000000	0.000000	0.000000	0.000000	0.067005
ESE	0.112690	0.000000	0.000000	0.000000	0.000000	0.000000	0.112690
SE	0.081218	0.000000	0.000000	0.000000	0.000000	0.000000	0.081218
SSE	0.021827	0.000000	0.000000	0.000000	0.000000	0.000000	0.021827
S	0.025381	0.000000	0.000000	0.000000	0.000000	0.000000	0.025381
SSW	0.030457	0.000000	0.000000	0.000000	0.000000	0.000000	0.030457
SW	0.048223	0.000000	0.000000	0.000000	0.000000	0.000000	0.048223
WSW	0.072081	0.000000	0.000000	0.000000	0.000000	0.000000	0.072081
W	0.105076	0.000000	0.000000	0.000000	0.000000	0.000000	0.105076
WNW	0.082741	0.000000	0.000000	0.000000	0.000000	0.000000	0.082741
NW	0.071574	0.000000	0.000000	0.000000	0.000000	0.000000	0.071574
NNW	0.036548	0.000000	0.000000	0.000000	0.000000	0.000000	0.036548
Total	0.777665	0.000000	0.000000	0.000000	0.000000	0.000000	

Frequency of Calm Winds : 22.23%

Average Wind Speed : 1.09 m/s

APPENDIX H.2

EVALUATION OF BEST AVAILABLE CONTROL TECHNOLOGY

BEST AVAILABLE CONTROL TECHNOLOGY REVIEW

Pursuant to EPA and SCAQMD requirements, a best available control technology (BACT) review is required for proposed facilities in attainment areas that have the potential to emit exceeding specified significant emission threshold levels. Significant is defined as an emissions increase that is equal to or greater than the following rates:

Nitrogen Oxide	40 tons per year
Carbon Monoxide	100 tons per year
Volatile Organic Compounds	40 tons per year
Sulfur Dioxide	40 tons per year
Particulate Matter less than 10 mm in Diameter	15 tons per year

Best available control technology (BACT) is defined in SCAQMD Rule 1302 as:

“the most stringent emission limitation or control technique which:

- (1) has been achieved in practice for such category or class of source; or
- (2) is contained in any state implementation plan (SIP) approved by the United States Environmental Protection Agency (EPA) for such category or class of source. A specific limitation or control technique shall not apply if the owner or operator of the proposed source demonstrates to the satisfaction of the Executive Officer or designee that such limitation or control technique is not presently achievable; or
- (3) is any other emission limitation or control technique, found by the Executive Officer or designee to be technologically feasible for such class or category of sources or for a specific source, and cost-effective as compared to measures as listed in the Air Quality Management Plan (AQMP) or rules adopted by the District Governing Board.”

For facilities located in non-attainment areas, the lowest achievable emission rate (LAER) replaces BACT in determining an appropriate level of control required for that facility and affected pollutant. LAER is similar to BACT, however LAER must be implemented regardless of cost. Item 1) listed above is essentially equivalent to federal LAER and applies to all of the project's criteria pollutant emissions. References to SCAQMD BACT are referred to as BACT, however, these BACT recommendations are equivalent to federal LAER.

The majority of criteria pollutant emissions from the facility will result from operation of the combustion turbine and duct burner. Minor emissions of criteria pollutants will result from the operation of the auxiliary boiler and the cooling tower will emit small amounts of PM₁₀. The criteria pollutants NO_x, CO, SO₂, PM₁₀, and O₃ (and/or their precursors) are subject to BACT. NO_x, CO, SO₂, and PM₁₀ are directly emitted. NO_x and SO₂ are precursors to PM₁₀. VOC and NO_x are precursors to O₃.

Top-Down BACT Methodology

The BACT analysis presented herein for the MPP follows the EPA's guidance for the preparation of "top-down" BACT analysis that focuses specifically on identifying emission limitations or control techniques that are achieved in practice and technically feasible (EPA, 1990). The top-down approach consists of a five-step evaluation of control technologies as follows:

1. Identify all control technologies
2. Eliminate technically infeasible options
3. Rank remaining control technologies by control effectiveness
4. Evaluate most effective controls and document results
5. Select BACT.

In a top-down BACT review, all applicable control technologies are considered first for technical feasibility. Control technologies are ranked most stringent to least stringent based on the level of emissions control. If the most stringent technology cannot be used because of technical considerations, it is removed from further consideration and the next most stringent technology is evaluated. This process continues until a technology cannot be removed from consideration because it has been achieved in practice. An applicant is allowed to proposed technology that is not yet demonstrated as "achieved in practice" if that technology can be proven to meet applicable requirements. It is through this process that more stringent emissions limits or advanced technologies become achieved in practice.

Combustion Turbine BACT

To evaluate BACT for the proposed combustion turbine, the SCAQMD BACT guidelines for large combustion turbines (equipment rating greater than 3 MW) were reviewed. The relevant BACT determinations for this analysis are shown in Table H.2-1. The SCAQMD BACT determination listed in Table H.2-1 is based on SCONox™ technology demonstrated on a 32 MW gas fired turbine.

**TABLE H.2-1
SCAQMD BACT GUIDELINE FOR LARGE COMBUSTION TURBINES**

POLLUTANT	BACT
Nitrogen Oxides	(2.5 ppmvd @ 15% O ₂) x (% efficiency/34%)
Sulfur Dioxide	No BACT level listed
Carbon Monoxide	10 ppmvd @ 15% O ₂
VOC	No BACT level listed
NH ₃	10 ppmvd @ 15% O ₂ (1-hour average)
PM ₁₀	No BACT level listed

The EPA RACT-BACT-LAER Clearinghouse (RBLC) was also consulted to review recent EPA BACT decisions for gas-fired combustion turbines. These BACT decisions are summarized in Table H.2-2 and show NO_x levels that are higher than what has recently been determined to be BACT in California. The EPA RBLC listings for CO BACT determinations also show slightly higher emission levels for CO as compared to recent determinations ranging from 6 to 10 ppmvd at 15 percent O₂.

The CARB's BACT Clearinghouse Database was also reviewed for recent BACT decisions regarding large combustion turbine projects in California. Relevant BACT decisions are summarized in Table H.2-3. NO_x levels shown in these determinations are as low as 2.5 ppm on a 3-hour average. None of these recent BACT decisions include a determination for CO, and the determinations for VOC include extremely low catalyst efficiencies (5 to 10%).

Finally, the CARB's Guidance for Power Plant Siting and Best Available Control Technology was also reviewed. The relevant BACT levels recommended in the CARB power plant guidance document are summarized in Table H.2-4.

The MPP Project proposes to use dry low- NO_x combustors (DLN) with selective catalytic reduction (SCR) to achieve a NO_x concentration of 2.0 ppmvd at 15 percent O₂ on a 3-hour average. Ammonia slip emissions will be limited to 5 ppmvd at 15 percent O₂ over a 3-hour average. An oxidation catalyst tuned for CO reduction will be used to control CO emissions to 6 ppmvd at 15 percent O₂ over a 3-hour average. Collateral reduction of VOC emissions will be achieved through the use of the oxidation catalyst, however performance and design will be based on achieving the necessary CO emission reductions. Emissions of PM₁₀ and SO₂ will be minimized through the exclusive use of utility-grade natural gas. These pollutant levels will achieve emission reductions consistent with the SCAQMD BACT guideline and the CARB BACT guideline for power plants. A more detailed top-down analysis for BACT is included as Attachment H.2-1.

TABLE H.2.2
GAS TURBINE BACT DETERMINATIONS FROM EPA RACT-BACT-LEAR CLEARINGHOUSE

FACILITY/LOCATION	DATE PERMIT ISSUED	EQUIPMENT/RATING	NO_x LIMIT/CONTROL TECHNOLOGY	CO LIMIT/CONTROL TECHNOLOGY
Alabama Power Company McIntosh, AL	7/10/97	100 MW combustion turbine w/ duct burner	15 ppm (dry low- NO _x burners)	n/a
Lordsburg L.P. Lordsburg, NM	6/18/97	100 MW combustion turbine	15 ppm (dry low- NO _x technology)	50 ppm (dry low- NO _x technology)
Mead Coated Board, Inc. Phenix City, AL	3/12/97	25 MW combustion turbine w/ fired HRSG	25 ppm (dry low- NO _x combustor)	28 ppm (proper design and good combustion practices)
Northern California Power Agency Lodi, CA	10/02/97	GE Frame 5 gas turbine	25 ppm	n/a
Portside Energy Corp. Portage, IN	5/13/96	63 MW gas turbine w/ unfired HRSG	n/a	10 ppm (good combustion)
Southwestern Public Service Hobbs, NM	2/15/97	Gas turbine	15 ppm w/o power augmentation 25 ppm w/ augmentation	good combustion practices

**TABLE H.2.3
GAS TURBINE BACT DETERMINATIONS FROM CARB CLEARINGHOUSE**

FACILITY/LOCATION	DATE PERMIT ISSUED	EQUIPMENT/RATING	NO_x LIMIT/CONTROL TECHNOLOGY	CO LIMIT/CONTROL TECHNOLOGY
Sutter Power Plant, CA FRAQMD	4/14/99 (Application no. 13005A and Application for Certification no. 97- AFC-2)	Two combine-cycle 1900 MMBtu/hr, gas-fired Westinghouse 501F gas turbines each nominally rated at 170 MW with 170 MMBtu/hr heat recovery steam generators driving a common 160 MW steam turbine	Dry low-NO _x combustors and selective catalytic reduction, plus low-NO _x duct burners, 2.5 ppmvd @ 15% O ₂ over 1 hour	Oxidation catalyst 4 ppmvd @ 15% O ₂ on a calculated day average
Crockett Cogeneration (C&H Sugar) , CA BAAQMD	10/5/93 (A/C no. S-201)	1780 MMBtu/hr G E model PG7221 (FA), i.e., Frame 7FA, with heat recovery steam generator having low NO _x duct burners with a total rated capacity of 349 MMBtu/hr producing 240 MW (combined cycle and cogeneration).	Dry low-NO _x combustors and a Mitsubishi Heavy Industries America selective catalytic reduction 5 ppmvd @ 15% O ₂	Engelhard oxidation catalyst 5.9 ppmvd @ 15% O ₂ (Approximately 90% control)
SEPCO Sacramento, CA Metropolitan AQMD	10/5/94 A/C no. 10883	920 MMBtu/hr combined cycle natural gas-fired General Electric Frame 7EA gas turbine-generator set with a supplemental firing capacity of 362.1 MMBtu/hr and producing 82 MW	Dry low NO _x combustion and selective catalytic reduction 5 ppmvd at 15% oxygen 9.90 lbm/hr (Applicant proposed 2.6 ppmvd at 15% oxygen to lower offset liability)	Oxidation catalyst
SMUD/Campbell Soup, CA Sacramento Metropolitan AQMD	8/9/88 A/C no. 8585 and 8586	600 MMBtu/hr gas-fired General Electric Frame 7 turbine with heat recovery steam generator producing 80 MWe (cogeneration)	Steam or water injection 25 ppmvd at 15% oxygen	
Basic American Foods Energy American H, CA Monterey Bay Unified APCD	7/8/87 A330-258-88	887.2 MMBtu/hr General Electric Frame 7 gas turbine producing 85.5 MW with a 36.4 MW steam turbine; unit will fire natural gas or FO no. 2 (cogeneration with combined cycle)	Steam injection and SCR Gas-firing: 0.034 lbm/MMBtu 9 ppmvd @ 15% O ₂ (15 ppmvd @ 15% O ₂ determined to be BACT by the district) Oil-firing: 0.054 lbm/MMBtu 15 ppmvd @ 15% O ₂ (23 ppmvd at 15% O ₂ determined to be BACT by the district)	

TABLE H.2.3
GAS TURBINE BACT DETERMINATIONS FROM CARB CLEARINGHOUSE

FACILITY/LOCATION	DATE PERMIT ISSUED	EQUIPMENT/RATING	NO_x LIMIT/CONTROL TECHNOLOGY	CO LIMIT/CONTROL TECHNOLOGY
La Paloma Generating Co. LLC, CA SJVUAPCD	5/26/99 A/C # S-3412-1-1 through 4-1; 98-AFC-2	Four 262 MW ABB model GT-24 combine cycle natural gas-fired turbines used for electric generation without supplemental firing; units are capable of steam augmentation.	Dry low-NO _x combustors and selective catalytic reduction 17.3 lbs/hr 2.5 ppmvd @ 15% O ₂	Oxidation catalyst 31.4 lbs/hr 10 ppmvd @ 15% O ₂ ≤ 221 MW 6 ppmvd @ 15% O ₂ > 221 MW
Carson Energy Sacramento Metropolitan AQMD	A330-854-98	GE LM6000 combined-cycle gas turbine w/ supplemental firing (42 MW)	5 ppm (water injection and SCR)	oxidation catalyst (10% destruction efficiency)
Sacramento Power Authority Sacramento Metropolitan AQMD	A330-852-98	Siemens V84.2 combined-cycle gas turbine w/ supplemental firing (103 MW)	3 ppm (water injection and SCR)	oxidation catalyst

TABLE H.2.4
CARB BACT GUIDANCE FOR POWER PLANTS

POLLUTANT	BACT
Nitrogen Oxides	2.5 ppmvd @ 15% O ₂ (1-hour average) 2.0 ppmvd @ 15% O ₂ (3-hour average)
Sulfur Dioxide	Fuel sulfur limit of 1.0 grains/100 scf
Carbon Monoxide	Non-attainment areas: 6 ppmvd @ 15% O ₂ (3-hour average) Attainment areas: District discretion
VOC	2 ppmvd @ 15% O ₂ (3-hour average)
NH ₃	5 ppmvd @ 15% O ₂ (3-hour average)
PM ₁₀	Fuel sulfur limit of 1.0 grains/100 scf

Auxiliary Boiler BACT

The CARB's BACT Clearinghouse Database was consulted to review recent BACT decisions for small industrial steam generators (i.e., approximately 6 MMBtu/hr). Recent BACT decisions are summarized in Table H.2-5. BACT determinations for boilers in this approximate size range are between 12 and 15 ppmvd at 3 percent O₂ with CO BACT levels of between 50 and 100 ppmvd at 3 percent O₂. VOC BACT is listed as 30 ppmvd. Only one of the BACT determinations found listed control levels for PM₁₀ at 0.007 lb/MMBtu without the use of controls.

The SCAQMD BACT Guidelines, Part D: BACT Guidelines for Non-Major Polluting Facilities (SCAQMD, October 2000) was also consulted. The BACT guidelines for natural gas fired boilers with a heat rating of less than 20 MMBtu/hr are shown in Table H.2.6. The BACT for NO_x is ≤ 12 ppmvd at 3 percent O₂, and the BACT for CO is ≤ 50 ppmvd (dry, corrected to 3% O₂) for firetube types and ≤ 100 ppmvd (dry, corrected to 3% O₂) for watertube type boilers. The BACT for PM₁₀ and SO_x is the use of natural gas fuel. No BACT guideline levels were listed for VOC or for inorganics. The BACT Guidelines for major polluting facilities are not expected to be any less stringent than those for non-major polluting facilities.

The Applicant proposes a BACT limit of 12 ppmvd NO_x at 3 percent O₂, and 50 ppmvd CO at 3 percent O₂ for the auxiliary boiler. The use of natural gas as an exclusive fuel will be used to achieve BACT for SO_x and PM₁₀; good combustion practice will be used to achieve BACT for VOC. These BACT levels are consistent with the SCAQMD Guidelines for natural gas fired boilers with a rating of ≤ 20 MMBtu/hr, and are consistent with the CARB BACT Clearinghouse determinations for boilers with ratings around 6 MMBtu/hr (refer to Tables H.2.5 and H.2.6 respectively). These levels are less than the BAAQMD BACT guidelines for natural gas fired boilers (refer to Table H.2.7).

The BAAQMD BACT Guideline for Boilers 5MMBtu/hr to 35.5 MMBtu/hr was also consulted. The BAAQMD determination is shown in Table H.2.7.

TABLE H.2.5
SUMMARY OF CARB BACT DETERMINATIONS FOR BOILERS ~ 6 MMBtu/hr

FACILITY/ DISTRICT	ISSUE DATE/ PERMIT NO.	EQUIPMENT/RATING	NO_x LIMIT/ CONTROL TECHNOLOGY	CO LIMIT/ CONTROL TECHNOLOGY	OTHER LIMITS/ CONTROL TECHNOLOGIES
Margaretis Textile Service/MTS Inc. SCAQMD	3/16/00 (A/C # 366323) A310-988-00	4.2 MMBtu/hr Kewanee model 100 H.P. natural gas-fired fire-tube boiler for use with a steam generator	NO _x Goal Line Environmental Technologies SCONOx catalytic absorption system 2 ppmvd @ 3% O₂ at applicant request (currently 2 ppmvd @ 3% O ₂ is not recognized as achieved in practice)		
San Bernardino County Medical Center SCAQMD	2/15/00 (A/C # 364142) A340-986-00	6 MMBtu/hr Cleaver Brooks model FLX-700-600 natural gas-fired water- tube boiler use for building heat. LPG used as emergency backup fuel. Unit will be used from November through March.	NO _x Alzeta model CSB ultra low-NOx burner 12 ppmvd @ 3% O₂ (natural gas) 30 ppmvd @ 3% O ₂ (LPG)	CO Alzeta model CSB ultra low-NOx burner 50 ppmvd @ 3% O₂ (natural gas) 400 ppmvd @ 3% O ₂ (LPG)	
Maruchan, Inc. SCAQMD	9/9/99 (A/C # 358116) A340-985-00	8.18 MMBtu/hr Miura model LX- 200SG natural gas-fired water-tube boiler use as the main boiler for process heating operating above 80% capacity	NO _x Miura ultra low-NOx burner 15 ppmvd @ 3% O₂	CO No control 100 ppmvd @ 3% O₂	
L&N Uniform Supply Co Inc. SCAQMD	4/6/00 (A/C # 367150) A310-982-00	6.3 MMBtu/hr Superior Boiler Works model 5-ACT-625-150M natural gas- fired fire-tube boiler	NO _x American Combustion Technology model ACT-04 low- NOx burner with flue gas recirculation 12 ppmvd @ 3% O₂	CO No control 100 ppmvd @ 3% O₂	

TABLE H.2.5
SUMMARY OF CARB BACT DETERMINATIONS FOR BOILERS ~ 6 MMBtu/hr

FACILITY/ DISTRICT	ISSUE DATE/ PERMIT NO.	EQUIPMENT/RATING	NO_x LIMIT/ CONTROL TECHNOLOGY	CO LIMIT/ CONTROL TECHNOLOGY	OTHER LIMITS/ CONTROL TECHNOLOGIES
La Paloma Generating Co. LLC SJVUAPCD	2/1/00 (A/C # S-3412- 12-0) A310-973-00	6.2 MMBtu/hr Cleaver Brooks model CBW7XX-150-150 natural gas-fired fire-tube boiler use as part of a cooling two blowdown water treatment process	NO _x Alzeta model CSB low-NO _x burner 12 ppmvd @ 3% O₂	CO Alzeta model CSB low-NO _x burner 50 ppmvd @ 3% O₂	PM No control 0.007 lb/MMBtu VOC/HC No control 30 ppmvd @ 3% O₂
Pacific Life Insurance SCAQMD	1/28/00 (A/C No.: 362486) A330-964-00	2,970,000 Btu/hr Parker model T- 2970LR natural gas-fired boiler use for space heating	NO _x Parker model MFB-36, premix metal fiber ultra low-NO _x burner 12 ppmvd @ 3% O₂	CO Parker model MFB- 36, premix metal fiber ultra low-NO _x burner 100 ppmvd @ 3% O₂	
Disneyland Resorts SCAQMD	12/21/99 (A/C No.: 360389) A310-946-00	Cleaver Brooks, model FLX, natural gas-fired water-tube boiler with a 8.5 MMBtu/hr Alzeta Model CSB84 ultra low-NO _x burner. Boiler is used to supply hot water to a hotel.	NO _x Alzeta ultra low-NO _x burner 12 ppmvd @ 3% O₂	CO Alzeta ultra low- NO _x burner 50 ppmvd @ 3% O₂	
SCHI Santa Monica Beach Hotel Associates SCAQMD	12/2/99 (A/C No.: 362396) A310-945-00	4.292 MMBtu/hr Clayton, model E6100-LNB, natural gas-fired water- tube boiler use to supply hot water	NO _x Ultra low-NO _x burner system 12 ppmvd @ 3% O₂	CO Ultra low-NO _x burner system 100 ppmvd @ 3% O₂	

TABLE H.2.5
SUMMARY OF CARB BACT DETERMINATIONS FOR BOILERS ~ 6 MMBtu/hr

FACILITY/ DISTRICT	ISSUE DATE/ PERMIT NO.	EQUIPMENT/RATING	NO_x LIMIT/ CONTROL TECHNOLOGY	CO LIMIT/ CONTROL TECHNOLOGY	OTHER LIMITS/ CONTROL TECHNOLOGIES
Doctors Medical Centers SJVUAPCD	1/5/98 (A/C no. N- 2333-10-0) A310-824-98	3.78 MMBtu/hr natural gas-fired boiler with low sulfur #2 fuel oil backup	NO _x Industrial Combustion burner and FGR 30 ppmvd @ 3% O₂		SO _x Natural gas as primary fuel with low sulfur fuel oil #2 (0.05% by weight) as backup No limit (Equivalent to 4.6 lbm/day)
California State Prison, Corcoran SJVUAPCD	1/15/97 (A/C no. C- 0214-32-0) A310-792-97	8.1 MMBtu/hr Clayton Industries Model SEG-204-2-LNB boiler	NO _x Premixed lean burn combustion technology 12 ppmvd at 3% O₂		
Toter, Incorporated SJVUAPCD	9/9/96 (A/C no. C-43- 6-0) A310-778-97	5.6 MMBtu/hr polyethylene curing oven incorporated with a Ferry RS-370	NO _x No control Natural gas, emissions < 0.07 lb/MMBtu @ 1000 Btu/SCF		
CalResources LLC SJVUAPCD	1/10/97 (A/C no. S- 1543-5-3 and -6- 3) A330-765-97	Modification of 13.6 MMBtu/hr Solar model 1100 Saturn gas turbine fired on natural gas driving a gas compressor. Unit has some heat recovery.	NO _x No control 69 ppmvd at 15% O₂ 3.61 lbm/hr w/o duct burner off		

TABLE H.2.5
SUMMARY OF CARB BACT DETERMINATIONS FOR BOILERS ~ 6 MMBtu/hr

FACILITY/ DISTRICT	ISSUE DATE/ PERMIT NO.	EQUIPMENT/RATING	NO_x LIMIT/ CONTROL TECHNOLOGY	CO LIMIT/ CONTROL TECHNOLOGY	OTHER LIMITS/ CONTROL TECHNOLOGIES
O.H. Kruse Grain and Milling Division of PM Ag Products, Inc. SJVUAPCD	9/19/96 (A/C no. S-160- 13-0) A370-751-97	10 MMBtu/hr (300 hp) Clayton Model EG 300 boiler used as a backup to a 21 MMBtu/hr (500 hp) boiler; use limited to 7 billion Btu/yr	NO _x No control 0.106 lb/MMBtu 25.4 lbm/day		VOC/HC 10 MMBtu/hr (300 hp) Clayton Model EG 300 boiler used as a backup to a 21 MMBtu/hr (500 hp) boiler; use limited to 7 billion Btu/yr PM No control 0.012 lbm/MMBtu 2.9 lbm/day
Vandenberg Air Force Base SBCAPCD	10/24/96 (A/C no. 9225) (PTO no 9225, issue date 2/27/97) A310-712-96	Two 8.4 MMBtu/hr, propane-fired Superior model no. 4-5-1024-W60-GP- G hot-water boilers	NO _x Zwick Energy model FC150-B- UV-LU low-emissions flameless burners 15 ppmvd at 3% O₂ 0.15 lbm/hr Source test results: boiler 1: 7.2 ppmvd @ 3% O ₂ boiler 2: 7.1 ppmvd @ 3% O ₂	CO Zwick Energy model no. FC150-B-UV-LU low-emissions flameless burners 50 ppmvd at 3% O₂ 0.31 lbm/hr Source test results boiler 1: <1 ppmvd @ 3% O ₂ boiler 2: <1 ppmvd @ 3% O ₂	

TABLE H.2.6
SUMMARY OF SCAQMD BACT GUIDELINES FOR BOILERS < 20 MMBtu/hr

Subcategory/Rating/Size	VOC	NO _x	SO _x	CO	PM ₁₀	Inorganics
Natural gas or Propane Fired, < 20 MMBtu/hr		≤ 12 ppmv dry corrected to 3% O ₂ ¹ (10-20-2000)	Natural Gas (10- 20-2000)	≤ 50 ppmv for firetube type, ≤ 100 ppmv for watertube type, dry corrected to 3% O ₂ (04- 10-98)	Natural Gas (04-10-98)	

¹ A higher NO_x limit may be allowed for facilities required to have a standby fuel, where use of a clean standby fuel is not possible and an ultra low NO_x burner is not available.

**TABLE H.2.7
BAAQMD BACT GUIDELINES**

POLLUTANT	<u>BACT</u>	TYPICAL TECHNOLOGY
	1. Technologically Feasible/ Cost Effective 2. Achieved in Practice	
POC	1. n/d 2. n/s	1. n/d 2. Good Combustion Practice ^a
NO _x	1. 20 ppmvd @ 3% O ₂ Dry ^{a,b,d} 2. 20 ppmvd @ 3% O ₂ Dry, for Firetube Boilers 25 ppmvd @ 3% O ₂ Dry, for Watertube Boilers ^{a,c,d}	1. Low NO _x Burners + Flue Gas Recirculation ^a 2. Low NO _x Burners + Flue Gas Recirculation ^a
SO ₂	1. Natural Gas or Treated Refinery Gas Fuel w/ ≤50 ppmvd Hydrogen Sulfide and ≤100 ppmvd Total Reduced Sulfur ^{a,c} 2. Natural Gas or Treated Refinery Gas Fuel w/ ≤100 ppmvd Total Reduced Sulfur ^{a,c}	1. Fuel Selection ^{a,c} 2. Fuel Selection ^{a,c}
CO	1. 50 ppmvd @ 3% O ₂ Dry ^{a,c,e} 2. 50 ppmvd @ 3% O ₂ Dry, for Firetube Boilers ^f 100 ppmvd @ 3% O ₂ Dry, for Watertube Boilers ^{a,c,e}	1. Good Combustion Practice ^{a,c} 2. Good Combustion Practice ^{a,c}
PM ₁₀	1. n/d 2. Natural Gas or Treated Refinery Gas Fuel ^{a,c}	1. n/d 2. Fuel Selection ^{a,c}
NPOC	1. n/a 2. n/a	1. n/a 2. n/a

a. BAAQMD.

b. Demonstrated for firetube boilers.

c. BACT is 25 ppmvd NO_x @ 3% O₂ and 50/100 ppmvd CO @ 3% O₂ regardless of fuel. However, emergency backup fuel oil w/ < 0.05 wt. % sulfur may be permitted to emit up to 60 NO_x ppmvd @ 3% O₂ and 100 ppmvd CO @ 3% O₂ during natural gas curtailment.

d. NO_x determination by BAAQMD source Test method ST-13A or B (average of three 30-minute sampling runs), or BAAQMD approved equivalent.

e. CO determination by BAAQMD Source Test Method ST-6 (average of three 30-minute sampling runs), or BAAQMD approved equivalent.

f. CO 100 ppmvd allowance for firetube boilers meeting the 20-ppmvd NO_x standard.

ATTACHMENT H.2-1

TOP-DOWN ANALYSIS FOR BACT FOR CT AND AUXILIARY BOILER

Top-Down BACT Analysis MPP Project

Combustion Turbine BACT

The BACT analysis for the proposed CT focuses on the emissions limitations for NO_x, CO, and ammonia. The use of natural gas as an exclusive fuel for the CT is generally agreed to represent the most stringent control available for SO₂ and PM₁₀. For large industrial combustion turbines, good combustion control is considered representative of the control required for BACT for VOC.

1. Control of Nitrogen Oxides

a. Identify All Control Technologies

The maximum NO_x emission rate for this analysis is considered to be 25 ppmvd at 15 percent O₂, based on vendor supplied data for the Westinghouse turbine alternative. This maximum emission rate provides the baseline for the evaluation of control effectiveness and feasibility. The maximum degree of control, resulting in the minimum emission rate, is a combination of dry low- NO_x combustors (DLN) and either selective catalytic reduction (SCR) or SCONOXTM to achieve a NO_x limit of 2 ppmvd. Intermediate levels of control are also evaluated.

There are three basic means of controlling NO_x emissions from combustion turbines: wet combustion controls, dry combustion controls, and post-combustion controls. Wet and dry combustion controls act to reduce the formation of NO_x during the combustion process, while post-combustion controls remove NO_x from the exhaust stream. Potential NO_x control technologies for combustion gas turbines include the following:

Wet combustion controls

- Water injection
- Steam injection

Dry combustion controls

- DLN
- Catalytic combustors (e.g., XONONTM)
- Other combustion modifications

Post-combustion controls

- Selective non-catalytic reduction (SNCR)
- Non-selective catalytic reduction (NSCR)

- SCR
- SCONO_xTM.

b. Eliminate Technically Infeasible Options

The performance and technical feasibility of available NO_x control technologies are discussed in more detail below.

Combustion Modifications

(i) Wet Combustion Controls

Steam or water injection directly into the turbine combustor is one of the most common NO_x control techniques for combustion turbines. These wet injection techniques lower the flame temperature in the combustor and thereby reduce thermal NO_x formation. The water or steam-to-fuel injection ratio is the most significant factor affecting the performance of wet controls. Steam injection techniques can reduce NO_x emissions in gas-fired gas turbines to between 15 and 25 ppmvd at 15 percent O₂; the practical limit of water injection has been demonstrated at approximately 25-42 ppmvd at 15 percent O₂ before combustor damage becomes significant. Higher diluent:fuel ratios (especially with steam) result in greater NO_x reductions, but also increase emissions of CO and hydrocarbons, reduce turbine efficiency, and may increase turbine maintenance requirements. The principal NO_x control mechanisms are identical for water and steam injection. Water or steam is injected into the primary combustion chamber to act as a heat sink, lowering the peak flame temperature of combustion and thus lowering the quantity of thermal NO_x formed. The injected water or steam exits the turbine as part of the exhaust.

Since steam has a higher temperature/enthalpy than water, more steam is required to achieve the same quenching effect. Typical steam injection ratios are 0.5 to 2.0 pounds steam per pound fuel; water injection ratios are generally below 1.0 pound water per pound fuel. Because water has a higher heat absorbing capacity than steam (due to the temperature and to the latent heat of vaporization associated with water), it takes more steam than water to achieve an equivalent level of NO_x control.

Although the lower peak flame temperature has a beneficial effect on NO_x emissions, it can also reduce combustion efficiency and prevent complete combustion. As a result, CO and VOC emissions increase as water/steam-to-fuel ratios increase. Thus, the higher steam-to-fuel ratio required for NO_x control will tend to cause higher CO and VOC emissions from steam-injected turbines than from water-injected turbines, due to the kinetic effect of the water molecules interfering with the combustion process. However, steam injection can reduce the heat rate of the turbine, so that equivalent power output can be achieved with reduced fuel consumption and reduced SO₂ emission rates.

Water and steam injection have been in use on both oil- and gas-fired turbines in all size ranges for many years so these NO_x control technologies are clearly technologically feasible and widely available.

(ii) Dry Combustion Controls

Combustion modifications that lower NO_x emissions without wet injection include lean combustion, reduced combustor residence time, lean premixed combustion and two-stage rich/lean combustion. Lean combustion uses excess air (greater than stoichiometric air-to-fuel ratio) in the combustor primary combustion zone to cool the flame, thereby reducing the rate of thermal NO_x formation. Reduced combustor residence times are achieved by introducing dilution air between the combustor and the turbine sooner than with standard combustors. The combustion gases are at high temperatures for a shorter time, which also has the effect of reducing the rate of thermal NO_x formation.

The most advanced combination of combustion controls for NO_x are DLN combustors. DLN technology uses lean, premixed combustion to keep peak combustion temperatures low, thus reducing the formation of thermal NO_x. This technology is effective in achieving NO_x emission levels comparable to levels achieved using wet injection without the need for large volumes of purified water and with smaller increases in CO and VOC emissions than from wet injection. Several turbine vendors have developed this technology for their engines, including the engines proposed for this project. This control technique is technically feasible.

Catalytic combustors use a catalytic reactor bed mounted within the combustor to burn a very lean fuel-air mixture. This technology has been commercially demonstrated under the trade name XONON™ in a 1.5 MW natural gas-fired turbine in California and commercial availability of the technology for a 200 MW GE Frame 7G natural gas-fired turbine was recently announced for one project. The combustor used in the demonstration engine is generally comparable in size to that used in GE Frame 7F engines; however, the technology has not been announced commercially for the Frame 7F engines proposed for this project. General Electric has indicated the technology is not yet commercially available. No turbine vendor, other than General Electric, has indicated the commercial availability of catalytic combustion systems at the present time; therefore, catalytic combustion controls are not available for this specific application and are not discussed further.

(iii) Post-Combustion Controls

SCR is a post-combustion technique that controls both thermal and fuel NO_x emissions by reducing NO_x with a reagent (generally ammonia or urea) in the presence of a catalyst to form water and nitrogen. NO_x conversion is sensitive to exhaust gas temperature, and performance can be limited by contaminants in the exhaust gas that may mask the catalyst (sulfur compounds, particulates, heavy metals, and silica). SCR is used in numerous gas turbine installations throughout the United States, almost exclusively in conjunction with other wet or dry NO_x combustion controls. SCR requires the consumption of a reagent (ammonia or urea), and requires periodic catalyst replacement. Estimated levels of NO_x control are in excess of 90percent.

Selective non-catalytic reduction (SNCR) involves injection of ammonia or urea with proprietary conditioners into the exhaust gas stream without a catalyst. SNCR technology requires gas temperatures in the range of 1200° to 2000° F and is most commonly used in boilers. The exhaust temperature for the proposed gas turbine ranges from 1087° to 1200° F, well below the minimum SNCR operating temperature. Some method of exhaust gas reheat, such as additional fuel combustion, would be required to achieve exhaust temperatures compatible with SNCR operations, and this requirement makes SNCR technologically infeasible for this application. Even when technically feasible, SNCR is unlikely to achieve NO_x reductions in excess of 80 to 85percent.

Non-selective catalytic reduction (NSCR) uses a catalyst without injected reagents to reduce NO_x emissions in an exhaust gas stream. NSCR is typically used in automobile exhaust and rich-burn stationary IC engines, and employs a platinum/rhodium catalyst. NSCR is effective only in a stoichiometric or fuel-rich environment where the combustion gas is nearly depleted of oxygen, and this condition does not occur in turbine exhaust where the oxygen concentrations are typically between 14 and 16 percent. For this reason, NSCR is not technologically feasible for this application.

SCONOx™ is a proprietary catalytic oxidation and absorption technology that uses a single catalyst for the removal of NO_x, CO, and VOC. The catalyst simultaneously oxidizes NO, CO, and VOCs and adsorbs NO₂ onto the catalyst surface where they are stored as nitrates and nitrites. The catalyst is a monolith design, made from a ceramic substrate, with a platinum-based catalyst and a potassium carbonate coating. The SCONOx™ catalyst has a limited adsorption capability, and requires regeneration on a cycle of approximately 12-15 minutes.¹ Regeneration occurs by dividing the SCONOx™ catalyst system in a series of sealable compartments. At any point in time, approximately 20 percent of the compartments in a SCONOx™ system would be in regeneration mode, and the remaining 80percent of the compartments would be in oxidation/absorption mode.

Regeneration of the SCONOx™ catalyst must occur in an oxygen-free environment. Consequently, each SCONOx™ compartment is equipped with front and rear seals to isolate the compartment from the exhaust gas stream during regeneration operation.

Regeneration is accomplished by passing a gas mixture (regeneration gases) containing methane, carbon dioxide and hydrogen over the catalyst beds. Regeneration gases are created using a separate, external reformer. Initial attempts to create regeneration gases from natural gas and steam within the SCONOx catalyst bed (internal autothermal regeneration) failed to produce consistent results and this technology is not being proposed by the vendor at the present time.

The SCONOx catalyst bed, as designed for F-class gas turbines, includes a SCOSOx™ catalyst (or guard bed) followed by two or more SCONOx™ catalysts in series. The SCOSOx™ catalyst is intended to remove trace quantities of sulfur-bearing compounds from

¹ Application for Certification, El Segundo Redevelopment Project (2000).

the exhaust gas stream, so as to avoid poisoning of the SCONOx™ catalyst. Like the SCONOx™ catalyst, the SCOSOx™ catalyst is regenerated. The regeneration for the two catalyst types occurs at the same time, with the same regeneration gas supply provided to both. Regeneration gases for the SCOSOx™ catalyst exit the module separately from the SCONOx™ regeneration gases; however, both regeneration gases are returned to the gas turbine exhaust stream downstream of the SCONOx™ module.

The external reformer used to create the regeneration gases is supplied with steam and natural gas. For one F-class turbine, an estimated 15,000 to 20,000 lbs/hr of 600°F steam is required, along with approximately 100 pounds per hour (2.2 MMBtu/hr) of natural gas. To avoid poisoning the reformer catalyst, the natural gas supplied to the reformer passes through an activated carbon filter to remove sulfur-bearing compounds.

To properly treat the exhaust gas without undue backpressure, an estimated 40-60 catalyst modules would be required for an F-class machine. (These modules are assembled, four to a shelf, to create 10-15 shelves.) The pressure drop associated with a NOx removal efficiency of 90percent is approximately 5 inches of water. The estimated space velocity for such a system is 22,000/hour.

The regeneration cycle time is expected to be controlled using a feedback system based on NOx emission rates. That is, the higher the NOx emissions relative to the design level are, the shorter the absorption cycle, and regeneration cycles will occur more frequently. This is analogous to the use of feedback systems for controlling reagent flow rates in an SCR system.

Maintenance requirements for SCONOx™ systems are expected to include periodic replacement of the reformer fuel-sulfur carbon-unit and reformer catalyst, periodic washings of the SCOSOx™ and SCONOx™ catalyst beds, and replacement of the SCOSOx™ and SCONOx catalyst beds. The replacement frequency for the reformer fuel-sulfur carbon-unit and reformer catalyst are unknown to SCAPPA at present. The SCOSOx™ catalyst is expected to require washing once per year with the lead SCONOx™ catalyst bed being washed once per year and the trailing SCONOx™ catalyst bed(s) being washed every three years. The annual catalyst washing process is expected to take approximately three days for an F-class machine, with an estimated annual cost of \$200,000. The estimated catalyst life is reported to be 7 washings; the guaranteed catalyst life is 3 years

The absorption operating temperature range for the SCONOx™ system is 300°F to 700°F, with an optimal temperature of approximately 600°F. Regeneration cycles are not initiated unless the catalyst bed temperature is above 450°F to avoid the creation of hydrogen sulfide during the regeneration of the SCOSOx™ catalyst.

Estimates of control system efficiency vary. The vendor has indicated that the SCONOx™ system is capable of achieving a 90 percent reduction in NOx. Commercially quoted NOx emission rates for the SCONOx™ system are 2.0 ppm on a 3-hour average basis, representing a 78 percent reduction. The vendor has stated that levels of 1 ppm with no

averaging time may be achieved, however these emission levels have not been demonstrated over a 6-month period as required for BACT determination.

The SCONOx™ system has been applied at the Sunlaw Federal Cogeneration Plant in Vernon California since December 1996, and at the Genetics Institute Facility in Massachusetts. The Sunlaw facility uses an LM-2500 gas turbine, rated at a nominal 23 MW, and the Genetics Institute facility has a 5 MW Solar gas turbine. Both of these turbine MW ratings and exhaust flow rates are significantly smaller than the proposed project F-Class turbine. The SCONOx™ system was proposed for use by the La Paloma Generating Company, LLC (LPGC) at its La Paloma facility; however, LPGC no longer plans to use the SCONOx™ system at that site. The SCONOx™ system is currently proposed for demonstration by the Otay Mesa Generating Company, LLC at the Otay Mesa Generating Project. The technology's co-developer, Sunlaw, has proposed to use the technology with ABB combustion turbines at the Nueva Azalea site in Southern California, however this project has been placed on hold. Therefore, while the SCONOx™ system has been used on small turbine applications, it has not been demonstrated as achieved in practice or technically feasible for F-Class turbines.

Based on the discussions above, the following NO_x control technologies are available and potentially technologically feasible for the proposed project:

- Water injection
- Steam injection
- Dry Low- NO_x Combustors
- Selective Catalytic Reduction
- SCONOx™ (potentially feasible; not demonstrated in practice on F-Class turbines).

c. Rank Remaining Control Technologies by Control Effectiveness

The remaining technically feasible control technologies are ranked by NO_x control effectiveness in Table H.2.8.

d. Evaluate Most Effective Controls and Document Results

Water and steam injection are control technologies that, for large gas turbines, have been largely superseded by DLN combustors due to the superior emission control performance, additional CO and VOC benefits, and increased efficiency of this technology. Since the project proposes to use DLN combustors, no further discussion of water injection, steam injection, or DLN combustors is necessary.

The performance of SCR and SCONOx™, insofar as NO_x emission levels are concerned, are essentially equivalent. Both technologies have the potential to reduce NO_x emissions by at least 90 percent, and differences between low NO_x levels (2 ppm vs 2.5 ppm) appear, in the case of each technology, to be largely a function of catalyst size, turbine outlet NO_x concentration, and compliance terms (e.g., averaging period).

TABLE H.2.8
NO_x CONTROL ALTERNATIVES – CT

NO_x Control Alternative	Available ?	Technically Feasible?	NO_x Emissions (@ 15% O₂)	Environmental Impact	Energy Impacts
Water Injection	Yes	Yes	25-42 ppm	Increased CO/VOC	Decreased Efficiency
Steam Injection	Yes	Yes	15 – 25 ppm	Increased CO/VOC	Increased Efficiency
Dry Low-NO _x Combustors	Yes	Yes	9-25 ppm	Reduced CO/VOC	Increased Efficiency
SCR	Yes	Yes	>90% reduction 2 – 2.5 ppm	Ammonia slip	Decreased efficiency
SCONOX	Yes ¹	Yes ²	>90% reduction 2 – 2.5 ppm	Reduced CO; potential reduction in VOC	Decreased efficiency

1. There are no standard, commercial guarantees for utility-scale projects for this technology available in the public domain.
2. Technology has been used on small (5 MW and 23 MW) gas turbines for a limited period of time. Has not been used on utility-scale gas turbines.

e. Select BACT

Based on the above analysis, both SCR and potentially SCONOX™-based systems are considered, in general, to be technologically capable of achieving NO_x levels below 2.5 ppm, given appropriate consideration to turbine outlet NO_x levels, catalyst volume (space velocity) and control system design. Although either technology may achieve the same emission rate, SCR has been demonstrated and achieved in practice to control NO_x. In contrast, SCONOX™ is potentially feasible but has not been demonstrated or achieved in practice on an F-Class turbine. At these low emission levels, some provision will be necessary to accommodate short-term excursions above permit limits, and particular attention to CEMS design will be necessary to ensure that low permit limits can be monitored on a continuous and accurate basis.

Established BACT for NO_x is considered to be the use of SCR to achieve NO_x levels not higher than 2.5 ppm on a 1-hour average basis, or 2.0 ppm on a 3-hour average basis. The MPP project proposes to use SCR technology to meet a NO_x level of 2.0 ppm on a 3-hour average basis. Consequently, MPP project's proposal is consistent with BACT requirements.

1. Control of Carbon Monoxide

a. Identify All Control Technologies

In addition to the XONON™ and SCONOX™ systems described above, CO emissions can be controlled through the use of conventional combustion control or catalytic oxidation. As

described above, the XONON™ and SCONOX™ systems are not currently commercially available or achieved in practice for the proposed turbines and therefore are not discussed further.

(1) Conventional Combustion Control/Design

The design and operation of large combustion turbines has improved considerable over recent years. The current generation of advanced combustion turbines are capable of maintaining CO emission levels of 10 to 20 ppmvd at base load down to 75 and even 50 percent load, depending on turbine manufacturer.

(2) Catalytic Oxidation

Oxidizing catalysts have been used to control CO emissions from combustion turbines for over 10 years. The catalysts are placed within a specified temperature range within the HRSG. The temperature range is based upon the exhaust characteristics as well as the catalyst material. Carbon monoxide is reacted on the catalyst surface with excess oxygen in the exhaust stream to form carbon dioxide. This technology is considered proven on large industrial combustion turbines.

b. Eliminate Technically Infeasible Options

As described above, XONON™ and SCONOX™ are not considered achieved in practice and are not discussed further. Both conventional combustion control and catalytic oxidation are achieved in practice for this source.

c. Rank Remaining Control Technologies by Control Effectiveness and Select BACT

CO oxidation catalyst has been shown to reduce CO emission to 10 ppmvd at 15 percent O₂ and below. The Crockett Cogeneration facility is currently permitted at a range of 6 to 10 ppmvd at 15 percent O₂. The La Paloma Generating Project is currently permitted using a two-tiered BACT determination where CO emissions at part load are limited to 10 ppmvd and base and high load CO emissions are limited to 6 ppmvd at 15 percent O₂. The Otay Mesa Generating Project is currently permitted at 6 ppmvd at 15 percent O₂, although this project has not yet been built.

The Applicant is confident that the proposed MPP project can be operated at 6 ppmvd at 15 percent O₂ and is proposing the use of an oxidation catalyst to achieve this proposed BACT level. Conventional combustion control is not currently capable of meeting this proposed BACT level.

2. Control of Ammonia Emissions

a. Identify All Control Technologies

Ammonia emissions result from the use of ammonia-based NO_x control technologies. Consequently, only an abbreviated discussion of these technologies is restated here.

There are three basic means of controlling NO_x emissions from combustion turbines: wet combustion controls, dry combustion controls, and post-combustion controls. These technologies were discussed above.

Water and steam injection are control technologies that, for large gas turbines, have been largely superseded by dry low-NO_x combustors, due to the superior emission control performance, additional CO and VOC benefits, and increased efficiency of this technology. Since the project proposes to use dry low NO_x combustors, no further discussion of water injection, steam injection, or dry low NO_x combustors is necessary.

b. Eliminate Technically Infeasible Options

The performance of SCR and SCONO_xTM, insofar as NO_x emission levels are concerned, has been discussed above.

c. Rank Remaining Control Technologies By Control Effectiveness

SCONO_xTM results in no emissions of ammonia, while SCR results in ammonia slip levels of up to 10 ppm. The following discussion evaluates potential ammonia slip limits of 10 ppm, 5 ppm, 2 ppm, and 0 ppm. The latter limit would potentially be attainable only through the use of SCONO_xTM technology, which has not been achieved in practice on F-Class machines.

d. Evaluate Most Effective Controls And Document Results

SCR has been achieved in practice at numerous combustion turbine installations throughout the world. Although there are a large number of gas turbines equipped with SCR systems, there are relatively fewer operating systems that are designed to meet low NO_x permit limits of 3.0 ppm or less. Ammonia slip associated with SCR system operation results from a gradual decline in catalyst activity over time, necessitating the use of increasing amounts of ammonia injection to maintain NO_x concentrations at or below the design rate.

The parameters of NO_x concentration, ammonia slip limit, and catalyst life are integrally related. That is, catalyst performance is generally specified as being a particular NO_x concentration (e.g., 2.5 ppm), guaranteed for N years (e.g., 3 years), with a maximum ammonia slip level of X ppm (e.g., 5 ppm). Such a specification indicates that catalyst performance will degrade over time such that at the end of three years, ammonia slip will increase to not more than 5 ppm while maintaining NO_x concentrations at or below 2.5 ppm. During the early period of performance, ammonia slip from an oxidation catalyst is typically less than 1-2 ppm, and will approach the guarantee level only towards the end of the catalyst life.

Early SCR installations, as well as some later installations, have been associated with ammonia slip levels of 10 ppm. In August 1999, the California Air Resources Board adopted a BACT guideline for large gas turbines that proposed to limit ammonia slip to not more than

5 ppm. Since the 5 ppm ammonia slip level is proposed for the MPP, no further discussion of the 10 ppm and 5 ppm slip levels is required.

SCONOX has the potential to achieve this low a NO_x level without any ammonia slip. Consequently, the following discussion compares the use of SCR with a 5 ppm ammonia slip level with SCONOX™ to meet comparable NO_x levels, but without any ammonia slip.

SCR technology is available with standard commercial guarantees with ammonia slip levels of 5 ppm and 2 ppm, in conjunction with NO_x levels at least as low as 2 ppm. SCR technology has been shown to be capable of achieving ammonia slip levels below 5 ppm over at least a three-year catalyst life period. There are no reported adverse effects of operation of the SCR system at these levels on overall plant operation or reliability.

The SCAQMD's web site lists three SCR-based BACT determinations for ammonia slip. The earliest SCR-based BACT determination for ammonia slip listed on the SCAQMD's web site is for the Sutter Power Project, which was approved by the Feather River AQMD in April 1999. This project is required to meet an ammonia slip limit of 10 ppm on a 3-hour average basis, in conjunction with a 2.5 ppm NO_x limit on a 1-hour average basis.

The next SCR-based BACT determination for ammonia slip listed on the SCAQMD's web site is for the La Paloma Generating project, which was approved by the San Joaquin Unified APCD in October 1999. This project is required to meet a 10 ppmvd ammonia slip limit on a 24-hour average basis in conjunction with a 2.5 ppm NO_x limit on a 1-hour average basis.

The third SCR-based BACT determination for ammonia slip listed on the SCAQMD's web site is for the Sithe Energy Mystic facility, which was approved by the Massachusetts Department of Environmental Protection (Mass DEP) in January 2000. This project is required to comply with a 2 ppm ammonia slip limit on a 1-hour average basis in conjunction with a 2 ppm NO_x limit, 1-hour average basis. The Sithe Mystic facility is also required to evaluate the availability, reliability, and cost of technologies that eliminate ammonia slip emissions, in accordance with the terms of a Memorandum of Understanding between the project operator and Mass DEP. Construction of the facility has not yet been completed, nor has compliance with these proposed emissions been demonstrated.

These permits indicate that, as recently as one year ago, ammonia slip limits of 10 ppm were considered best available control technology. The rapid changes during the last year are indicative of SCR system vendors attempting to achieve low ammonia slip rates in conjunction with low NO_x emission rates.

Consequently, if an SCR-based control system is selected, BACT for ammonia slip should be an emission limit of 5 ppm.

Since SCONOX™ technology to eliminate ammonia slip may be potentially technologically feasible, a further evaluation of the cost/effectiveness of this technology was performed. In this analysis, the cost of a SCONOX™ system was compared with the cost of an SCR and oxidation catalyst system, with the incremental cost assigned to the benefit of eliminating

ammonia slip emissions. (It is appropriate to make such an assignment because the performance of the SCR and oxidation catalyst systems are comparable to that proposed for SCONOx with respect to NO_x and CO emission levels for this project.)

As shown in Tables H.2.9 through H.2.12, the results of this analysis indicate that the incremental cost/effectiveness of the SCONOxTM system for the purpose of reducing ammonia emissions is nearly \$50,000 per ton.

The South Coast AQMD no longer publishes cost/effectiveness criteria for use in performing BACT analyses. In the absence of SCAQMD-specific criteria, the following values are presented to provide a reference for the calculated cost/effectiveness of SCONOxTM as an ammonia control device. Since ammonia is regulated as a precursor to PM₁₀, the values shown below represent the BACT cost/effectiveness thresholds for PM₁₀:

Bay Area AQMD -	\$5,300 /ton
San Joaquin Valley Unified APCD -	\$5,700 /ton

While these values are not, by themselves, determinate, they indicate that the cost/effectiveness of using SCONOxTM to eliminate ammonia emissions is well in excess of costs that are normally required for the control of PM₁₀ in BACT determinations in areas of California that exceed the state and/or federal PM₁₀ air quality standards.

e. Select BACT

Based on the above information, BACT for ammonia is considered to be an ammonia slip limit of 5 ppm. SCONOxTM has the potential to eliminate ammonia emissions; however, this candidate technology was rejected for the reasons discussed above.

The MPP project proposes to use SCR technology to meet an ammonia slip limit of 5 ppm in conjunction with NO_x levels of 2 ppm on a 3 hour average basis. Consequently, MPP project's proposal is consistent with BACT requirements for ammonia emissions.

Table H.2.9
SCR Costs (per gas turbine/HRSG)

Description of Cost	Cost Factor	Cost (\$)	Notes
Direct Capital Costs (DC):			
Purchased Equip. Cost (PE):			
Basic Equipment:			
Auxiliary Equipment: HRSG tube/fin modifications			
Instrumentation: SCR controls			
Ammonia storage system:			
Taxes and freight:			
PE Total:		\$1,620,000	1
Direct Install. Costs (DI):			
Foundation & supports:	0.08 PE	\$129,600	2
Handling and erection (included in PE cost):		\$0	1
Electrical (included in PE cost):		\$0	1
Piping (included in PE cost):		\$0	1
Insulation (included in PE cost):		\$0	1
Painting (included in PE cost):		\$0	1
DI Total:		\$129,600	
Site preparation for ammonia tanks		\$10,000	1
DC Total (PE+DI):		\$1,759,600	
Indirect Costs (IC):			
Engineering:	0.10 PE	\$162,000	2
Construction and field expenses:	0.05 PE	\$81,000	2
Contractor fees:	0.10 PE	\$162,000	2
Start-up:	0.02 PE	\$32,400	2
Performance testing:	0.01 PE	\$16,200	2
Contingencies:	0.05 PE	\$81,000	1
IC Total:		\$534,600	
Less: Capital cost of initial catalyst charge		-\$975,000	
Total Capital Investment (TCI = DC + IC):		\$1,319,200	
Direct Annual Costs (DAC): 0.5 hr/SCR per			
Operating Costs (O): sched. (hr/day)24	day/week: 7	hr/yr: 4,380	
Operator: hr/shift: 1.0	operator pay (\$/hr): 39.20	\$42,806	2
Supervisor: 15% of operator		\$6,421	2
Maintenance Costs (M): 0.5 hr/SCR per shift			
Labor: hr/shift: 1.0	labor pay (\$/hr): 39.2	\$42,806	2
Material: % of labor cost:100%		\$42,806	2
Utility Costs:			
Perf. loss: (kwh/unit): 347.6			1
Electricity cost (\$/kwh): 0.0336	Performance loss cost penalty:	\$102,311	5
Ammonia based on 153 lbs/hr of 24.5% wt aqueous ammonia, \$0.05/lb		\$73,883	1, 4
Catalyst replace: based on 3 year catalyst life		\$325,000	1
Catalyst dispose: based on 2,750 ft ³ catalyst, \$15/ft ³ , 3 yr. Life		\$13,750	1
Total DAC:		\$649,784	
Indirect Annual Costs (IAC):			
Overhead: 60% of O&M		\$80,904	2
Administrative:	0.02 TCI	\$26,384	2
Insurance:	0.01 TCI	\$13,192	2
Property tax:	0.01 TCI	\$13,192	2
Total IAC:		\$133,672	
Total Annual Cost (DAC + IAC):		\$783,456	
Capital Recovery (CR):			
Capital recovery: interest rate (%): 10			
period (years): 15	0.1315	\$173,440	2
Total Annualized Costs		\$956,897	

Table H.2.10
Oxidation Catalyst Costs (per gas turbine/HRSG)

Description of Cost	Cost Factor	Cost (\$)	Notes
Direct Capital Costs (DC):			
Purchased Equip. Cost (PE):			
Basic Equipment:			
Auxiliary Equipment: HRSG tube/ fin modifications			
Instrumentation: oxidation cat. Controls			
Taxes and freight:			
PE Total:		\$725,000	1
Direct Install. Costs (DI):			
Foundation & supports:	0.08 PE	\$58,000	2
Handling and erection (included in PE cost):		\$0	1
Electrical (included in PE cost):		\$0	1
Piping (included in PE cost):		\$0	1
Insulation (included in PE cost):		\$0	1
Painting (included in PE cost):		\$0	1
DI Total:		\$58,000	
DC Total (PE+DI):		\$783,000	
Indirect Costs (IC):			
Engineering:	0.10 PE	\$72,500	2
Construction and field expenses:	0.05 PE	\$36,250	2
Contractor fees:	0.10 PE	\$72,500	2
Start-up:	0.02 PE	\$14,500	2
Performance testing:	0.01 PE	\$7,250	2
Contingencies:	0.05 PE	\$36,250	1
IC Total:		\$239,250	
Less: Capital cost of initial catalyst charge		-\$350,000	
Total Capital Investment (TCI = DC + IC):		\$672,250	
Direct Annual Costs (DAC):			
Operating Costs (O): sched. (hr/ da 24 day/ week: 7 hr/ yr: 4,380 wk/ yr: 52			
Operator: hr/ shift: 0.0 operator pay (\$/ hr): 39.20		\$0	2
Supervisor: 15% of operator		\$0	2
Maintenance Costs (M): 0.5 hr/ oxidation cat. per shift			
Labor: hr/ shift: 0.0 labor pay (\$/ hr): 39.2		\$0	2
Material: % of labor cos 100%		\$0	2
Utility Costs:			
Perf. loss: (kwh/ unit): 172.5			1
Electricity cost (\$/ kwh): 0.0336 Performance loss cost penalty:		\$50,773	5
Catalyst replace: based on 3 yr. Life		\$116,667	1
Catalyst dispose: based on 240 ft ³ catalyst, \$15/ ft ³ , 3 yr. Life		\$1,200	1
Total DAC:		\$168,640	
Indirect Annual Costs (IAC):			
Overhead: 60% of O&M		\$0	2
Administrative: 0.02 TCI		\$13,445	2
Insurance: 0.01 TCI		\$6,723	2
Property tax: 0.01 TCI		\$6,723	2
Total IAC:		\$26,890	
Total Annual Cost (DAC + IAC):		\$195,530	
Capital Recovery (CR):			
Capital recovery factor (CRF): interest rate (%): 10			
period (years): 15 0.1315		\$88,383	2
Total Annualized Costs		\$283,913	

Table H.2.11

SCONox Cost and Cost/Effectiveness (per gas turbine/HRSG)

Description of Cost	Cost (\$)	Notes
Direct Capital Costs		
Capital (less cost of initial catalyst charge)	\$3,900,000	3, 7
Installation	\$1,700,000	3
Indirect Capital Costs		
Engineering	\$200,000	3
Contingency	\$250,000	3
Other	-	
Total Capital Investment	\$6,050,000	
Direct Annual Costs		
Maintenance	\$250,000	3
Ammonia	-	3
Steam/Natural Gas	\$400,000	3
Pressure Drop	\$226,000	3
Catalyst Replacement (based on 3-yr catalyst life)	\$3,033,333	7, 8
Catalyst Disposal	\$0	
Total Direct Annual Costs	\$3,909,333	
Indirect Annual Costs		
Overhead	-	3
Administrative, Tax & Insurance	\$225,000	3
Total Indirect Annual Costs	\$225,000	
TOTAL ANNUAL COST	\$4,134,333	
Capital Recovery Factor	0.1315	2
Capital Recovery	\$795,416	
TOTAL ANNUALIZED COSTS	\$4,929,750	

SCONox Ammonia Cost Effectiveness (per gas turbine/HRSG)

Description of Cost	Cost (\$)	Notes
SCONox Annualized Costs	\$4,929,750	
SCR Annualized Costs	\$956,897	
Oxidation Cat. Annualized Costs	\$283,913	
SCR/Oxidation Cat. Annualized Costs	\$1,240,809	
Incremental Annualized Costs	\$3,688,940	
Annual Ammonia Emissions with SCR (tons/yr)	52.5	6
Annual Ammonia Emissions with SCONox (tons/yr)	0	
Reduction in Ammonia Emissions (tons/yr)	52.5	
SCONox COST EFFECTIVENESS (\$/ton removed)	\$70,266	

Table H.2.12

Notes: SCONOx Ammonia Cost Effectiveness Analysis

Note No.	Source
1	Based on information from Duke/Fluor Daniel.
2	From EPA/OAQPS Control Cost Manual. EPA-450/3-90-006. January 1990.
3	From April 12, 2000 letter from ABB Alstom Power to Matt Haber EPA Region IX (SCONOx capital cost of \$13,000,000).
4	Based on anhydrous ammonia cost of \$450/ton.
5	Based on current average price of power in the project area.
6	Based on G.E. 7FA Gas Turbine/HRSG operating at 100% load, 95 deg. F ambient, duct burner on, ammonia slip of 5 ppm @ 15% O ₂ , operating 24 hours per day, 365 days per year.
7	Based on information from May 8, 2000 "Testimony of J. Phyllis Fox, Ph.D. on Behalf of the California Unions for Reliable Energy on Air Quality Impacts of the Elk Hills Power Project", cost of replacement catalyst for SCONOx is 70% of initial capital investment.
8	Based on information from the Application for Certification, El Segundo Redevelopment Project (2000), indicating that SCONOx catalyst life is guaranteed for a 3-year period.

Top-down BACT Analysis for the Proposed Auxiliary Boiler

The BACT analysis for the proposed auxiliary boiler comprises an evaluation of NO_x and CO. As previously mentioned, the use of natural gas is considered BACT for PM₁₀ and SO₂. The use of good combustion practice will be used to achieve BACT for VOC and CO emissions.

1. Control of Nitrogen Oxides

a. Identify All Control Technologies

The possible control technologies to achieve BACT for NO_x emissions include flue gas treatment (SCR/ SCONO_xTM) and combustion modifications (ultra low NO_x burners, flue gas recirculation (FGR), and lean burn combustion technology).

b. Eliminate Technically Infeasible Options

All of the above control technologies are technically feasible.

c. Rank Remaining Control Technologies by Control Effectiveness

The control technologies, ranked by NO_x control effectiveness, are listed below in Table H.2.13.

**TABLE H.2.13
NO_x CONTROL ALTERNATIVES – AUXILIARY BOILER**

NO_x Control Alternative	Available ?	Technically Feasible?	NO_x Emissions (@ 3% O₂)	Environmental Impact	Energy Impacts
SCONOX	Yes	Yes	>90% reduction ~ 2 ppm	Reduced CO; potential reduction in VOC	Decreased efficiency
SCR	Yes	Yes	>90%	Ammonia slip	Decreased efficiency
Ultra low NO _x burners	Yes	Yes	5 - 30 ppm	Reduced CO/ VOC	Increased Efficiency
Ultra low NO _x burners & FGR	Yes	Yes	12 - 30 ppm	Reduced CO/ VOC	Increased Efficiency
Lean Burn Combustion Technology	Yes	Yes	12 ppm	Reduced CO/ VOC	Increased Efficiency

d. Evaluate Most Effective Controls and Document Results

SCONOx™: SCONOx™ for NO_x control has previously been evaluated (refer to the discussion for the CT “Post-Combustion Controls part (iii)”). SCONOx has been utilized in a small natural gas fired boiler with a rated heat input of 4.2 MMBtu/hr with a resultant NO_x limit of 2 ppmvd at 3 percent O₂; however this limit was set at the Applicant’s request, and not as a limit that is recognized as achieved in practice.

SCR Systems: Refer to discussion for the CT, under “Post Combustion Modification part (iii)” for further evaluation of SCR systems in NO_x control. In the BACT determinations carried out for the auxiliary boiler, none of the cases reviewed utilized SCR for NO_x control.

Ultra low NO_x burners: The use of ultra low NO_x burners is one of the most common forms of NO_x control for boilers. Ultra low NO_x burners inhibit NO_x formation by controlling the mixing of fuel and air through the use of low excess air firing or staged combustion.

The most stringent NO_x limit using ultra low NO_x burners reported is 2 ppmvd at 3 percent O₂ (CARB, 6 MMBtu/hr watertube boiler). The commonly permitted NO_x level for boilers of a comparable size to the proposed auxiliary boiler that utilize ultra low NO_x burners is 12 ppmvd at 3 percent O₂ (SCAQMD, CARB). The Bay Area AQMD (BAAQMD) lists 20 ppmvd at 3 percent O₂ for NO_x as BACT using low NO_x burners and FGR for firetube boilers and 25 ppmvd at 3 percent O₂ as BACT for watertube boilers.

Flue gas recirculation: FGR involves rerouting of some of the flue gas (usually from the economizer outlet) back to the furnace. In this way the furnace air temperature and the furnace oxygen concentration are simultaneously reduced, hence NO_x production is reduced.

The units reviewed in the BACT determinations that utilized FGR and low NO_x burners reported NO_x limits of 12 ppmvd at 3 percent O₂.

Lean burn combustion technology: Lean burn combustion technology involves manipulation of the air to fuel ratio in the boiler in a similar manner to ultra low NO_x burner technology, thus reducing the amount of NO_x produced in the combustion reaction.

The BACT limit utilizing lean burn combustion technology for NO_x control from the determinations reviewed was 12 ppmvd at 3 percent O₂.

It should be noted that, in the BACT determinations reviewed, the units where no NO_x control was used reported NO_x levels of around 14 ppm at 3 percent O₂.

e. Select BACT

Based on the above information, BACT for NO_x is considered to be 12 ppm at 3 percent O₂ and 50 ppmvd CO at 3 percent O₂ for the auxiliary boiler. The use of natural gas as an exclusive fuel is BACT for SO_x and PM₁₀; and good combustion practice is BACT for VOC.

APPENDIX H.3
CONSTRUCTION IMPACT ANALYSIS

Construction/Demolition Phase Impacts

H.3.1 Onsite Construction

Construction of the Magnolia Power Project is expected to last 25 months, with the construction occurring in the following five main phases:

- Demolition of existing structures (refer to project description, Section 3.0)
- Site preparation
- Foundation work
- Installation of major equipment
- Construction/installation of major structures, and
- Start up and commissioning.

A detailed construction schedule is shown in Section 3.8.

Site preparation includes clearing, grading, excavation of footings and foundations, and backfilling operations. After site preparation is finished, the construction of the foundations and structures is expected to begin. Once the foundations and structures are finished, installation and assembly of the mechanical and electrical equipment are scheduled to commence.

Fugitive dust emissions from the construction of the MPP will result from dust entrainment during site preparation and grading/excavation, onsite travel on paved and unpaved surfaces, soil moving operations and aggregate and soil loading and unloading operations; and wind erosion of disturbed areas during construction activities.

Combustion emissions during construction will result from the operation of construction equipment during the demolition and construction phases. Construction equipment will include primarily diesel-fueled equipment. A list of scheduled construction equipment and SCAQMD emission factors used to estimate emissions are shown in Appendix H.3-1.

To determine the potential worst-case daily construction impacts, combustion and dust emission rates have been evaluated for each source of emissions. Worst-case daily dust emissions are expected to occur during months D-2 through construction month 15 when site preparation occurs. The worst-case daily combustion emissions are expected to occur during construction month eight. Annual emissions for each pollutant are based on the worst four quarters of emissions during the 25-month demolition and construction period.

H.3.2 Demolition Activities

The demolition activities are scheduled to occur over approximately a 2 month period during which demolition and removal of the remaining components associated with Magnolia Units 1 and 2 are anticipated to occur. The demolition phase will not reach the workforce and equipment levels expected during the construction phase of the project. Therefore, emissions from demolition activities will be lower than emissions from construction activities and they are not assessed further.

H.3.3 Available Mitigation Measures

The following mitigation measures are proposed to control exhaust emissions from the diesel heavy equipment used during construction of the MPP:

- Operational measures, such as limiting engine idling time and shutting down equipment when not in use
- Regular preventive maintenance to prevent emission increases due to engine problems
- Use of low-sulfur and low-aromatic fuel meeting California standards for motor vehicle diesel fuel
- Use of low-emitting diesel engines meeting federal emissions standards for construction equipment as applicable.

The following mitigation measures are proposed to control fugitive dust emissions during construction of the project:

- Vacuum sweeping and/or water flushing of paved road surface to remove buildup of loose material to control dust emissions from travel on the paved access road (including adjacent public streets impacted by construction activities) and paved parking areas.
- Cover all trucks hauling soil, sand, and other loose materials, or require all trucks to maintain at least two feet of freeboard.
- Limit traffic speeds on unpaved surfaces to 25 mph.
- Install sandbags or other erosion control measures to prevent silt runoff to roadways.
- As needed, use gravel pads along with wheel washers or wash tires of all trucks exiting construction site that carry track-out dirt from unpaved surfaces.
- Mitigate fugitive dust emissions from wind erosion of areas disturbed from construction activities (including storage piles) by application of either water or chemical dust suppressant and/or use of wind breaks.

H.3.4 Estimation of Emissions with Mitigation Measures

H.3.4.1 Onsite Construction

Tables H.3-1 through H.3-3 show the estimated maximum daily and annual heavy equipment exhaust and fugitive dust emissions with recommended mitigation measures for onsite construction activities. Detailed emission calculations are included as Attachment H.3-1.

**TABLE H.3-1
MAXIMUM HOURLY EMISSIONS DURING ONSITE CONSTRUCTION
(LB/HOUR)**

Source	NO _x	CO	VOC	SO _x	PM ₁₀
Construction Equipment	21.77	14.93	2.52	1.84	1.32
Fugitive Dust	--	--	--	--	1.7

**TABLE H.3-2
MAXIMUM DAILY EMISSIONS DURING ONSITE CONSTRUCTION
(LB/DAY)**

Source	NO _x	CO	VOC	SO _x	PM ₁₀
Construction Equipment	174.20	119.42	20.14	14.71	10.58
Fugitive Dust	--	--	--	--	13.6

**TABLE H.3-3
ANNUAL EMISSIONS DURING ONSITE CONSTRUCTION
(TONS/YEAR)**

Source	NO _x	CO	VOC	SO _x	PM ₁₀
Construction Equipment	17.66	11.28	2.05	1.49	1.08
Fugitive Dust	--	--	--	--	1.77

H.3.5 Analysis of Ambient Impacts from Onsite Construction

Ambient air quality impacts from emissions during construction of the MPP were estimated using an air quality dispersion modeling analysis. The modeling analysis considers the construction site location, the surrounding topography, and the sources of emissions during construction, including vehicle and equipment exhaust emissions and fugitive dust.

H.3.5.1 Existing Ambient Levels

The Burbank-West Palm Avenue (Burbank) Monitoring Station was used to establish the representative ambient background levels for the construction impact modeling analysis. Table H.3-4 shows the maximum concentrations of NO_x, SO₂, CO, and PM₁₀ recorded for 1997 through 1999 at the Burbank monitoring station.

H.3.5.2 Dispersion Modeling

As in the analysis of project operating impacts, the EPA-approved Industrial Source Complex Short Term (ISCST3) model (version 00101) was used to estimate ambient impacts from construction activities. A detailed discussion of the ISCST3 dispersion model is included in Section 5.2.4.3.

**TABLE H.3-4
MODELED MAXIMUM CONSTRUCTION IMPACTS**

Pollutant	Averaging Time	Maximum Construction Impacts (µg/m ³)	Background (µg/m ³)	Total Impact (µg/m ³)	State Standard (µg/m ³)	Federal Standard (µg/m ³)
NO _x	1-Hour	540	376	916	470	--
	Annual ¹	13.2	85	98.2	--	100
SO ₂	1-Hour	45.7	92	137.7	650	--
	24-Hour	7.2	18	25.2	109	365
	Annual	1.1	5	6.1	--	80
CO	1-Hour	370	10,534	10,904	23,000	40,000
	8-Hour	252	10,225	10,477	10,000	10,000
PM ₁₀	24-Hour	32.5	92	124.5	50	150
	Annual ²	7.1	42	49.1	30	--
	Annual ³	7.1	45	52.1	--	50

¹ Ambient ratio method (ARM) applied for annual average, using SCAQMD default ratio of 0.71.

² Annual Geometric Mean.

³ Annual Arithmetic Mean.

The emission sources for the construction site were grouped into two categories: construction equipment exhaust emissions and fugitive dust emissions. For modeling purposes, equipment exhaust emissions were totaled and divided into four onsite point sources. An effective emission plume height of 3.05 meters was used for all equipment exhaust emissions. The assumed stack diameter, exit velocity, and exhaust temperatures were 0.15 meters, 40 m/s, and 700 °F (644 °K). The fugitive dust emissions were modeled as a single volume source with a release height of 3.05 meters. The approximate on-site area of the fugitive dust source is estimated to be 3.1 acres (12,545 m²). The construction impacts modeling analysis used the same receptor locations as used for the project operating impact analysis. A detailed discussion of the receptor locations is included in Section 5.2.4.3.2.

To determine the construction impacts on short-term ambient standards (24 hours and less), the worst-case daily and hourly onsite construction emission levels shown in Tables H.3-1 and H.3-2 were used. For pollutants with annual average ambient standards, the annual onsite emission levels shown in Table H.3-3 were used. As with the project operating impact analysis, the meteorological data used for the construction emission impacts analysis were collected at the Burbank Monitoring Station during 1981.

H.3.6.3 Modeling Results

Based on the emission rates of NO_x, SO₂, CO, and PM₁₀ and the meteorological data, the ISCST3 model calculates hourly and annual ambient impacts for each pollutant. As mentioned above, the modeled 1-hour, 3-hour, 8-hour, and 24-hour ambient impacts are based on the worst-case hourly and daily emission rates of NO_x, SO₂, CO, and PM₁₀. The annual impacts are based on the worst-case annual emission rates of these pollutants.

The annual average concentrations of NO₂ were computed following the revised EPA guidance for computing these concentrations (August 9, 1995 *Federal Register*, 60 FR 40465), using the ambient ratio method (ARM) with the SCAQMD default value of 0.71 for the annual average NO₂/NO_x ratio.

The modeling analysis results are shown in Table H.3-4. Also included in the table are the maximum background levels that have occurred at the Burbank Monitoring Station in the last three years and the resulting total ambient impacts. As shown in Table H.3-4, with the exception of 24-hour and annual PM₁₀ impacts, 1-hour NO_x and 8-hour CO impacts, construction impacts are expected to be below the state and national standards. However, the state 24-hour and annual PM₁₀ standards, the national annual PM₁₀ standard, and the 8-hour CO standard are exceeded in the absence of the construction emissions for the MPP.

The ISCST3 model tends to over-predict PM₁₀ construction emission impacts because of the cold plume (i.e., ambient temperature) effect of dust emissions. Most of the plume dispersion characteristics in the ISCST3 model are derived from observations of hot plumes associated with typical smokestacks. The ISCST3 model does compensate for plume temperature; however, for ambient temperature plumes, the model assumes negligible buoyancy and dispersion. Consequently, the ambient concentrations in cold plumes remain high even at significant distances from a source. The MPP construction site impacts are not unusual in

comparison to most construction operations for greenfield major source power generation facilities. The applicant has proposed the use of construction mitigation measures to minimize potential impacts. The input and output modeling files are being provided electronically under separate cover.

Appendix H.3.1

DETAILED CONSTRUCTION EMISSION CALCULATIONS

Magnolia Power Project - Emission Factors for On-Site Plant Construction Equipment

Construction Equipment	Horse-power Rating	Fuel	Equipment Category	SCAQMD Table ¹	CO	ROC	NOx	SOx	PM10
10,000 lb-Class Excavator	---	Diesel	Miscellaneous	A9-8-A	0.675	0.15	1.7	0.143	0.14
973 Track Loader	---	Diesel	Tracked Loader	A9-8-A	0.201	0.095	0.83	0.076	0.059
Water Truck	100	Diesel	Dumpers/Tendons	A9-8-B	0.006	0.002	0.021	0.002	0.0015
Skid Steer Loader	---	Diesel	Wheeled Loader	A9-8-A	0.572	0.23	1.9	0.182	0.17
Hi-Side Semi End Dumps	---	Diesel	Trucks: Off-Highway	A9-8-A	1.80	0.19	4.17	0.45	0.26
Hydrocrane	---	Diesel	Miscellaneous	A9-8-A	0.675	0.15	1.7	0.143	0.14
Crawler Backhoe Cat 320 Track	84	Diesel	Tractr/Lodr/Bckho	A9-8-B	0.015	0.003	0.022	0.002	0.001
Crawler Backhoe Cat 320 Track	84	Diesel	Tractr/Lodr/Bckho	A9-8-B	0.015	0.003	0.022	0.002	0.001
Crawler Backhoe J.D 690 Track	115	Diesel	Tractr/Lodr/Bckho	A9-8-B	0.015	0.003	0.022	0.002	0.001
Backhoe 1.0 Cy	84	Diesel	Tractr/Lodr/Bckho	A9-8-B	0.015	0.003	0.022	0.002	0.001
Loader-Frontend 2cyd	80	Diesel	Rubber Tired Loader	A9-8-B	0.011	0.002	0.023	0.002	0.0015
Loader-Frontend 3cyd	100	Diesel	Rubber Tired Loader	A9-8-B	0.011	0.002	0.023	0.002	0.0015
Bulldozer Cat /D7	---	Diesel	Tracked Tractor	A9-8-A	0.350	0.120	1.260	0.140	0.112
Grader, 200 Hp 14 Ft	---	Diesel	Motor Grader	A9-8-A	0.151	0.039	0.713	0.086	0.061
Dump Truck, Diesel, 4x2 6yd Highway use	225	Diesel	Dumpers/Tendons	A9-8-B	0.006	0.002	0.021	0.002	0.0015
Vibratory plate	5	Diesel	Plate Compactor	A9-8-B	0.007	0.002	0.020	0.002	0.001
Rammer / Jumping Jack	25	Diesel	Other Const. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Riding, Vibrator Compactor	100	Diesel	Rollers	A9-8-B	0.007	0.002	0.020	0.002	0.001
Asphalt Paver	100	Diesel	Asphalt Pavers	A9-8-B	0.007	0.001	0.023	0.002	0.001
Asphalt Cutter/Grinder	100	Diesel	Concrete Saws	A9-8-B	0.02	0.024	0.002	0.003	0.001
Asphalt Compactor, Tandem	---	---	---	---	---	---	---	---	---
Steel Drum Roller	100	Diesel	Rollers	A9-8-B	0.007	0.002	0.020	0.002	0.001
Backhoe 1.0 Cy	84	Diesel	Tractr/Lodr/Bckho	A9-8-B	0.015	0.003	0.022	0.002	0.001
Loader-Frontend 2cyd	80	Diesel	Rubber Tired Loader	A9-8-B	0.011	0.002	0.023	0.002	0.0015
Grader, 200 Hp 14 Ft	---	Diesel	Motor Grader	A9-8-A	0.151	0.039	0.713	0.086	0.061
Air Compressors (375CFM)	50	Diesel	Other Const. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Air Compressors (185CFM)	25	Diesel	Other Const. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Concrete Pump	190	Diesel	Cement/Mortar Mix	A9-8-B	0.010	0.002	0.024	0.002	0.001
Skyclimbers	70	Diesel	Aerial Lifts	A9-8-B	0.013	0.003	0.031	0.002	0.0015
Scissors Lift	42	Diesel	A9-8-B	A9-8-B	---	---	---	---	---
JLG 120 ft	75	Diesel	Aerial Lifts	A9-8-B	0.013	0.003	0.031	0.002	0.0015
JLG 120 ft	75	Diesel	Aerial Lifts	A9-8-B	0.013	0.003	0.031	0.002	0.0015
JLG 60 ft	75	Diesel	Aerial Lifts	A9-8-B	0.013	0.003	0.031	0.002	0.0015
JLG 60 ft	75	Diesel	Aerial Lifts	A9-8-B	0.013	0.003	0.031	0.002	0.0015
Forklift Extended Boom	---	Diesel	Fork Lift - 175 Hp	A9-8-A	0.520	0.17	1.54	---	0.093
Forklift 4.0T Standard (or Forktruck)	---	Diesel	Fork Lift - 50 Hp	A9-8-A	0.180	0.053	0.441	---	0.031
Manitowac 4600 250T, Ringer; Main Crane for HRSG Modules	350	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Manitowac 4100, 200 T; Tailing Crane for HRSG Modules	350	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 110 Ton	250	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 55 Ton	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 55 Ton	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 55 Ton	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 35 Ton	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Hydraulic Truck Crane 22 Ton	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
22 Ton (crane dedicated for XFMR assembly, fill and testing)	185	Diesel	Cranes	A9-8-B	0.009	0.003	0.023	0.002	0.0015
Cable Pulling Equip	450	Diesel	Other Const. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
7000 W Portable generators	15	Diesel	Generator Sets < 50 Hp	A9-8-B	0.11	0.002	0.018	0.002	0.001
7000 W Portable generators	15	Diesel	Generator Sets < 50 Hp	A9-8-B	0.11	0.002	0.018	0.002	0.001
Mark VIII	7.5	Diesel	Generator Sets < 50 Hp	A9-8-B	0.11	0.002	0.018	0.002	0.001
Mark VIII	7.5	Diesel	Generator Sets < 50 Hp	A9-8-B	0.11	0.002	0.018	0.002	0.001
Mark VIII	7.5	Diesel	Generator Sets < 50 Hp	A9-8-B	0.11	0.002	0.018	0.002	0.001
Welder -Miller 400d	23	Diesel	Other Constr. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Welder -Miller 400d	23	Diesel	Other Constr. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Welder -Miller 400d	23	Diesel	Other Constr. Equip.	A9-8-B	0.020	0.003	0.024	0.002	0.0015
Highway Tractor	---	Diesel	Wheeled Tractor	A9-8-A	3.58	0.18	1.27	0.09	0.14
Flat Bed Truck w/Rails	---	Diesel	Trucks: Off-Highway	A9-8-A	1.80	0.19	4.17	0.45	0.26
Mechanic Truck	---	Diesel	Trucks: Off-Highway	A9-8-A	1.80	0.19	4.17	0.45	0.26
Boom Truck, 8 Ton	100	Diesel	Dumpers/Tendons	A9-8-B	0.006	0.002	0.021	0.002	0.0015
Water Truck 4x2 2500 gal	100	Diesel	Dumpers/Tendons	A9-8-B	0.006	0.002	0.021	0.002	0.0015

¹ South Coast Air Quality Management District CEQA Air Quality Handbook, 1993.

² AP-42 Table 3.4-2 (Large Uncontrolled Stationary Diesel Engines) emission factors in lbs/hp-hr, except PM10 (SCAQMD, Table A9-8-A, "Miscellaneous", in lb/hr). ROC emission factor is for Total Non-Methane Hydrocarbons (TNMHC).